3.3 BIOLOGICAL RESOURCES

3.3.1 Introduction

This section presents the existing environment and impacts analysis of biological resource issues associated with the granting of a new lease to Shore Terminals to continue to operate its marine terminal in southwestern Suisun Bay. Section 3.3.2 describes the existing conditions and includes discussion of the regulatory framework on a federal, state, and local level. Section 3.3.2 provides information on biological resources in the San Francisco Bay Estuary and, in more detail, for the project area (Suisun Bay and Carquinez Strait) as well as the immediate vicinity of Shore Terminals' facility.

Section 3.3.3 is the impacts analysis. Biological resources have the potential to be impacted by routine operations related to the Shore terminal or by an accidental release of crude oil or product. Impacts of routine operations are analyzed first followed by a discussion of potential oil spill impacts. A spill of crude oil or product could have wide ranging effects on biological resources in San Francisco Bay. Finally, mitigation measures will be discussed for all significant impacts identified in the impacts analysis.

3.3.2 Existing Conditions

3.3.2.1 Regulatory Setting

Several federal, state, and local agencies have jurisdiction over the biological resources of the San Francisco Bay-Delta estuary. Federal agencies directly responsible for the protection of biological resources are the U.S. Fish and Wildlife Service (USFWS) and the National Oceanographic and Atmospheric Administration (NOAA) Fisheries. The U.S. Environmental Protection Agency (EPA) is also concerned with the protection of marine and estuarine life through the regulation of water quality standards.

The California Department of Fish and Game (CDFG) is responsible for the protection of biological resources at the state level, as well as species officially listed as threatened or endangered by the state, candidates for listing as threatened or endangered, and California Species of Special Concern. The CDFG also regulates fishing and hunting and protects habitat quality. In addition, the CDFG administers the California Oil Spill Prevention and Response Act. The California Coastal Commission (CCC) is responsible for coastal zone management along the coast, except for San Francisco Bay. The California State Water Resources Board sets water quality standards for the protection of aquatic life. These standards are overseen on a local level by the SF-RWQCB.

The San Francisco Bay Conservation and Development Commission (BCDC) is responsible for coastal zone management within the San Francisco Bay/Delta estuary. The BCDC regulates dredging, filling, and land use in San Francisco Bay below the line of highest tidal action as well as 100 feet inland of the line of highest tidal action.

Legislation applicable to the protection of biological resources in San Francisco Bay-Delta estuary and the California outer coast is discussed in the following sections.

Federal Acts

Clean Water Act (CWA) of 1972

The CWA was established to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Specific sections of the CWA control the discharge of pollutants and wastes into freshwater and marine environments. Sections 401 of the CWA addresses dredging activities, and requires that dredging and disposal activities must not cause concentrations of chemicals in the water column to exceed state standards. Section 404(b)(1) guidelines require that dredging and disposal activities should have no unacceptable adverse impacts on the ecosystem of concern.

The National Estuary Program was established in 1987 by amendments to the CWA to identify, restore, and protect nationally significant estuaries of the United States. The San Francisco Estuary Project is one of over 20 Estuary Projects established by the National Estuary Program. The San Francisco Estuary Project is a cooperative federal, state and local program to promote effective management of the San Francisco Bay-Delta Estuary.

Marine Protection, Research, and Sanctuaries Act of 1972

Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) regulates the transportation and disposal of material in the ocean, and includes regulations and restrictions on the type of material that may be disposed. The U.S. Army Corps of Engineers (Corps) and EPA may prohibit or restrict disposal of material that does not meet the criteria outlined in 40 CFR Part 227.

Fish and Wildlife Coordination Act of 1958

The Fish and Wildlife Coordination Act requires that whenever a body of water is proposed to be controlled or modified, the lead agency must consult the state and federal agencies responsible for fish and wildlife management (USFWS, CDFG, and NOAA). This act allows for recommendations addressing adverse impacts associated with a Proposed Project, and for mitigating or compensating for impacts on fish and wildlife.

Marine Mammal Protection Act

The Marine Mammal Protection Act prohibits the taking (including harassment, disturbance, capture, and death) of any marine mammals except as set forth in the act.

Coastal Zone Management Act of 1972

The Coastal Zone Management Act requires federal agencies conducting activities directly affecting the coastal zone to proceed in a manner consistent with approved state coastal zone management programs.

Endangered Species Act of 1973

The Endangered Species Act protects threatened and endangered species by prohibiting federal actions that would jeopardize the continued existence of such species or adversely affect the critical habitat of these species. The act requires the agencies to consult the USFWS and NOAA, which will evaluate the potential impacts of all aspects of the project on any threatened or endangered species, and provide alternatives or measures to minimize effects caused by a Proposed Project.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act protects certain migratory birds including all seabirds by limiting hunting, capturing, selling, purchasing, transporting, importing, exporting, killing, or possession of the birds, or their nests or eggs.

Oil Pollution Act of 1990

The Oil Pollution Act of 1990, along with the Oil Pollution Liability and Compensation Act of 1989, provides for cleanup authority, penalties, and liability for oil pollution. The Oil Pollution Act creates the Oil Spill Compensation Fund to pay for removal of and damages from oil pollution.

National Invasive Species Act of 1996

This act calls for the implementation of measures to halt the spread of invasive species. To comply with this act, the USCG proposes voluntary guidelines to control the invasion of aquatic nuisance species via ship ballast water (North 1998).

Magnuson-Stevens Fishery Management and Conservation Act, as amended (16 U.S.C. 1801 et seq.)

The 1996 amendments to the Magnuson-Stevens Fishery Management and Conservation Act set forth a number of new mandates for the NOAA, regional fishery management councils, and other federal agencies to identify and protect important marine and anadromous fish habitat. The Councils, with assistance from NOAA, are required to delineate “essential fish habitat” (EFH) for all managed species. The Act defines EFH as “… those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NOAA regarding the potential effects of their actions on EFH, and respond in writing to the fishery service's recommendations. For the Pacific region, EFH has been identified for a total of 89 species covered by three fishery management plans (FMPs) under the auspices of the Pacific Fishery Management Council.

State Acts

California Endangered Species Act of 1984

This act provides for the recognition and protection of rare, threatened, and endangered species of plants and animals.

California Coastal Act of 1976 as Amended 1983

The California Coastal Act provides various levels of protection for areas of special concern through designations of marine life refuges, reserves, ecological reserves, and areas of special biological significance.

Oil Spill Prevention and Response Act of 1990

The Oil Spill Prevention and Response Act of 1990 (SB 2040) requires that a state oil spill contingency plan be established with a specific component to include a marine oil spill contingency planning element.

California Wetlands Conservation Policy (California Executive Order W-59-93)

This state policy recognizes the value of marshlands and other wetlands. The policy states that there be no net loss of wetland acreage and a long-term gain in the quantity, quality, and permanence of wetland acreages and values in California.

McAteer-Petris Act

This act established the San Francisco Bay Plan for the protection of the Bay and its natural resources and the development of the Bay and shoreline to their highest potential with a minimum of Bay fill. This Act established the San Francisco BCDC as the agency responsible for maintaining and carrying out the provisions of the Act. The Act directs the BCDC to exercise its authority to issue or deny permit applications for placing or extracting materials, or changing the use of any land, water, or structure within the area of its jurisdiction, in conformity with the provisions and policies of both the McAteer-Petris Act and the San Francisco Bay Plan.

California Ballast Water Management for Control of Nonindigenous Species Act of 1999 (AB 703)

This Act requires vessels to employ prescribed ballast water management practices to reduce the uptake and release of nonindigenous species into state waters. The bill requires the SLC to take samples of ballast water and sediment and to take other action to assess the compliance of any vessel with the prescribed requirements.

3.3.2.2 San Francisco Bay Estuary

Biological Characteristics of the Estuary

Because tankers that service the Shore marine terminal travel throughout San Francisco Bay, all of the tidally influenced biological resources of the estuary may be at some risk from operations at the marine terminal. Therefore, this section provides a brief overview of the biological resources of the estuary. The tidally influenced biological resources of the San Francisco Bay estuary are described in detail in the Unocal EIR (Chambers Group 1994).

The San Francisco Bay estuary, which extends from the mouth of Coyote Creek near the city of San Jose in the south to Chipps Island at the eastern end of Suisun Bay, is the largest coastal embayment on the Pacific Coast of the United States (Figure 3.3-1). It has a surface area of 1,166 square kilometers (km^2) (450 square miles). San Francisco Bay is located at the mouth of the Sacramento-San Joaquin River system, which carries runoff from 40 percent of the surface area of California (Nichols et al. 1986). The Bay is characterized by broad shallows with an average depth of 6 meters (m) MLLW (Conomos et al. 1985). The deepest sections of the Bay are channels at the Golden Gate (110 m depth) and Carquinez Strait (27 m depth), whose depths are maintained by strong tidal currents. As shown in Figure 3.3-1, the San Francisco estuary consists of five distinct subareas: Suisun Bay, Carquinez Strait, San Pablo Bay, Central Bay, and South Bay. Each of these areas has its own characteristic biological assemblage.

Reduction in freshwater inflows from the Sacramento and San Joaquin Rivers has profoundly altered the aquatic environment of the estuary. The freshwater inflow to San Francisco Bay is less than 50 percent of historic levels (Monroe and Kelly 1992). Diversion of water from the Sacramento-San Joaquin River system away from San Francisco Bay has had profound effects on the marine resources of the Bay, most noticeably on the anadromous fishes such as striped bass and salmon, which live part of their lives in the open ocean but depend on the rivers for spawning. The CALFED Bay-Delta Program was established by state and federal agencies in 1994 to find a long-term solution to water supply and environmental problems in the Bay and Delta (CALFED 1998). The biological resources of San Francisco Estuary also have been affected profoundly by the introduction of non-indigenous species. Introduced species are discussed in detail in the next section.

Phytoplankton production is the major source of organic matter in the estuary (Jassby et al. 1996; Corps, EPA, BCDC, SFBRWQCB, and SWRCB 1998). While the phytoplankton community in Central Bay is similar to the open ocean, the community in the northern reaches of the estuary is unique and has undergone profound changes in the last two decades. Phytoplankton distribution in the northern reach is characterized by an extremely high population in the entrapment zone, which usually occurs near the 2 parts per thousand (ppt) isohaline (San Francisco Estuary Project 1997). This zone of high production is important to several fish species (Kimmerer et al. 1998). In addition to a high concentration of phytoplankton, maximum abundances of several species of

Figure 3.3-1 The Major Regions of San Francisco Bay

zooplankton occur in the entrapment zone (Kimmerer et al. 1998). The entrapment zone is usually positioned in Suisun Bay in spring and summer. The complex interactions between movement of the salt field, gravitational circulation, and retention of particles and organisms in the entrapment zone are currently being studied (San Francisco Estuary Project 1997). There have been recent reductions in the abundance of phytoplankton in Suisun Bay, apparently because of intensive filter feeding by the Asian clam, *Potamocorbula amurensis* (Herbold et al. 1991), an invasive introduced species, first reported in the estuary in 1986. Phytoplankton populations in the northern reaches of the Estuary may now be continuously and permanently controlled by introduced clams (Cohen and Carlton 1995). Since the appearance of *Potamocorbula* the summer diatom bloom has disappeared, presumably because of increased filter feeding (Kimmerer 1998). The *Potamocorbula* population in the northern reaches of the estuary can filter the entire water column over the channels more than once per day and over the shallows almost 13 times per day (Cohen and Carlton 1995).

The most abundant zooplankton species in San Francisco Bay is the copepod, *Acartia clausi*. Standing stocks as high as 150,000 individuals per square meter have been recorded in the southern reach (Davis 1982). In the northern reach, this coastal species is found with zooplankton species characteristic of brackish waters (Painter 1966, Kimmerer and Orsi 1996, Corps and Contra Costa County 1997). Overall, three species (*Acartia clausi*, *Eurytemora affinis*, and *Neomysis mercedis*) have been found to be the most abundant species both in the channels and in the shallow flats of San Pablo and Suisun Bays. Dominant zooplankters distribute themselves in the estuary according to salinity. *Acartia clausi* is found in more saline water. *Eurytemora affinis* is always most abundant near fresh water in salinities less than 10 ppt.

Most species of copepods have shown pronounced long-term declines in abundance in the San Francisco Bay estuary system (Herbold et al. 1991, CalFed 1998). Invasion of the western Delta and Suisun Bay by the introduced copepods, *Sinocalanus doerri*, in 1978 and *Pseudodiaptomus forbesi* in 1987, was followed by declines in *Eurytemora affinis* and the almost complete elimination of another copepod, *Diaptomus* spp. Most copepods, including *Acartia*, have been at low abundance in Suisun Bay since the arrival and spread of the Asian clam. Research suggests that the decrease in *E. affinis* in Suisun Bay was by direct loss to clam filtration (Lehman 1998).

The opossum shrimp, *Neomysis mercedis*, is an especially important zooplankton species in the northern reach because it is the dominant species in the diet of young-of-the-year fishes (Orsi and Knutson 1979). This species is most abundant at salinities up to 10 ppt and is almost never found at salinities greater than 20 ppt (Davis 1982). *Neomysis* is found in most abundance in Suisun Bay and the western Delta (Herbold et al. 1991). *Neomysis* abundance is related to outflows from the Delta. When outflows are high, phytoplankton populations spread out into the broad shallows of Suisun Bay; light levels are high and a bloom occurs providing more food for opossum shrimp (Herbold and Moyle 1989). During years of low flows, the entrapment zone moves upstream into the deep channels of the Sacramento River, and productivity declines with a subsequent decline in *Neomysis* populations. The *Neomysis* population has declined to less than one-tenth of its former abundance, particularly since 1986 (CALFED 1998). The continuing decline in the 1990's despite the return of higher river outflows is of particular concern. The observed declines in zooplankton abundance have roughly coincided with the decline in phytoplankton, one of the main food sources for zooplankton (CALFED 1998). The deterioration of the zooplankton community and its phytoplankton food supply in key habitat areas of the Bay-Delta is a serious problem because striped bass (*Morone saxatilis*), Delta smelt (*Hypomesus transpacificus*), Chinook salmon (*Oncorhynchus tshawytscha*), and other species that use Suisun Bay and the Delta as a nursery area feed almost exclusively on zooplankton during early life.

Except for limited areas of natural rocky shores near the Golden Gate and in Central Bay, and manmade hard substrate in the form of riprap, docks, and pilings, most of the substrate throughout the San Francisco Bay estuary consists of soft bottom. Almost all the common benthic invertebrates in San Francisco Bay are introduced species. As with the plankton community, each of the Bays of San Francisco estuary has its own characteristic soft bottom benthic community (Davis 1982). The distribution of soft bottom benthic species in San Francisco Bay is most closely correlated to temporal variations in salinity and to sediment type (Lowe 1999). The greatest number of species is found in Central Bay which most closely resembles that of the open ocean. Away from the marine environment of Central Bay, the benthos is characterized by low diversity and dominated by a few species that are common to many North American estuaries and are tolerant of wide variations in salinity. Because most of the estuary is dominated by these few opportunistic species, the species compositions of the intertidal mudflats, the shallow subtidal, and the ship channels are similar. In general, the shallow subtidal supports a greater number of species than either the intertidal mudflats or the ship channels.

Special interest benthic species in San Francisco Bay include Dungeness crabs, grass shrimp, and a plant, eelgrass. Dungeness crab (*Cancer magister*) is a valuable commercial fishery for San Francisco and has been for over a century (Corps, EPA, BCDC, SFBRWQCB, and SWRCB 1998). San Francisco Bay is an important nursery area for Dungeness crabs (Tasto 1979; Herbold et al. 1991). Studies have demonstrated that Dungeness crab reared in San Francisco Estuary grow at about twice the rate of ocean-reared crabs (Baxter et al. 1999). Dungeness crabs enter San Francisco Bay as juveniles during March through June (Baxter et al. 1999). By September young crabs are widely distributed in San Pablo and lower Suisun Bays. The crabs leave the Bay by August or September of the following year. Dungeness crabs are particularly abundant from Richardson's Bay upstream through Suisun Bay, showing greater abundance upstream during years of low outflow. San Pablo Bay is the area of most consistently high numbers of juvenile Dungeness crabs.

The smaller epibenthic fauna of San Francisco Bay is dominated by four species of shrimp known as grass shrimp (Herbold et al. 1991, Reilly et al. 2001). These shrimp are important prey for estuary fishes and also support a commercial bait fishery (Corps, EPA, BCDC, SFBRWQCB, and SWRCB 1998). Grass shrimp include three native species (*Crangon franciscorum*, *C. nigricauda*, and *C. nigromaculata*) and one introduced species (*Palaemon macrodactylus*). *Crangon franciscorum* (California bay shrimp) are most abundant in lower salinities with young occurring in water that is almost fresh; *C. nigricauda* (blacktail bay shrimp) prefer salinities of 25 ppt or more; and *C. nigromaculata* (blackspotted bay shrimp) are seldom found at salinities below 30 ppt (Herbold et al. 1991). *Palaemon macrodactylus* is most common in lower salinity areas (Reilly et al. 2001). The center of its distribution is Suisun Bay and the West Delta.

Eelgrass (*Zostera marina*) is an important shallow subtidal and intertidal flowering plant of bays and estuaries. Eelgrass beds are recognized as a particularly valuable type of marine habitat that enhances the physical and biological environment where they occur (Phillips 1988). Eelgrass beds are highly productive (Ware 1993). In addition, these beds stabilize the substrate and add structure to the monotonous soft bottom. Several studies have demonstrated that the marine life in eelgrass meadows is enhanced in numbers, species, and standing crop compared to unvegetated soft bottom habitat (summarized in Ware 1993). Eelgrass beds in San Francisco Estuary are found from lower San Pablo Bay to South Bay at Coyote Point. The depth range of eelgrass in San Francisco Bay is from Mean Lower Low Water (MLLW) to 1.5 meters (5 feet) below MLLW (Caltrans 2001). Eelgrass habitats are dynamic, expanding and contracting by as much as several hectares per season, depending on the variations in key environmental factors.

Over 100 species of fish have been recorded from the San Francisco Bay estuarine system (Armor and Herrgesell 1985). These species vary in the way they use the Bay, from those that spend their entire lives in the Bay to those that spend only part of their life cycle there. The only fish species confined entirely to the Bay-Delta estuary is the Delta smelt, although the ecologically similar longfin smelt (*Spirinchus thaleichthys*) occurs very rarely outside the Golden Gate (Herbold et al. 1991). All other species maintain at least part of their population outside the San Francisco Bay-Delta estuary system. In general, the fishes of the San Francisco estuary fall into four categories: true estuarine species, freshwater species, marine species, and anadromous species (Corps, EPA, BCDC, SFBRWQCB, SWRCB 1998). San Francisco Bay is basically a marine environment, although salinities can be appreciably diluted by freshwater during high outflow years allowing freshwater fishes to move into the tributary streams (Moyle 2002).

Marine species include those which are only seasonally present and those that maintain at least part of their population in San Francisco Bay year-round. Seasonal species comprise many of the most abundant species found in the Bay (Herbold et al. 1991). Abundant seasonal species include northern anchovy (*Engraulis mordax*) and Pacific herring (*Clupea harengus*).

Anadromous species are those that spend their adult lives in the open ocean and come into fresh water to spawn. Anadromous species use the San Francisco Bay estuary on their way up the rivers to spawn and as a rearing area for juveniles on their way down from their birthplace in the river to the open ocean (Herbold et al. 1991). Native anadromous species include Chinook salmon, steelhead trout (*Oncorhynchus mykiss gairdneri*) and both green and white sturgeon (*Acipenser medirostris* and *A. transmontanus*). Introduced anadromous species include striped bass (*Morone* *satatilis*), and American shad (*Alosa sapidissima*). Anadromous species are sensitive to a wide variety of environmental changes, including upstream alteration of spawning habitat, interference with access to spawning habitat, changes in flow patterns, and conditions in the estuary that reduce its value as a nursery site for outmigrating young (Herbold et al. 1991).

Vegetated tidal marshes are an extremely productive and important habitat in the San Francisco estuary. More than 91 percent of the tidal wetlands in San Francisco Bay estuary have been lost to reclamation for farmland, salt evaporation ponds, and residential or industrial development (USGS 2002). Recent efforts have been made to protect and restore tidal marshes in the Bay. Three types of tidal marshes, related to extent of freshwater influence, are found in the San Francisco Bay estuary: saltmarsh, brackish marsh, and freshwater marsh. These marshes are exposed to the rise and fall of tides and are characterized by emergent vascular plants. Tidal cycles affect the vertical extent of marshes as well as their inundation period and tidal flushing.

Dominant plant species define the three marsh types, and zonation patterns of the dominant species within the marshes are apparent. In general, saltmarsh wetlands are dominated by Pacific cordgrass (*Spartina foliosa*) and pickleweed (*Salicornia virginica*), brackish marshes are dominated by various species of bulrush, and freshwater marshes are dominated by bulrush, reed grass (*Phragmites communis*), and cattails (*Typha* spp.). Differences in species composition between tidal marshes and plant zonation within marshes are based on plant physiological responses to physical factors of inundation, salinity, and sedimentation. In addition, interspecific competition can be a significant factor determining plant distributions in tidal marshes. Because most marsh plants reproduce vegetatively, each species can respond relatively quickly to favorable physical conditions and, therefore, seasonality can also affect the patterns of plant distribution in the tidal marshes (Josselyn 1983).

Tidal marsh occurs throughout the San Francisco estuary. The largest areas of tidal marsh are on the northern edge of San Pablo Bay and along the Petaluma River. Suisun Bay, too, supports a substantial acreage of tidal marsh, while Central Bay supports relatively little.

In addition to tidal wetlands, the San Francisco estuary includes diked wetlands, areas that have been isolated from natural tidal action. The largest area of diked wetlands is in the northern part of Suisun Bay and the Sacramento-San Joaquin Delta.

San Francisco Estuary is vitally important to many species of water-associated birds. San Francisco Estuary is important as a major refuge for many species of shorebirds and waterfowl during their migration and wintering season (August through April) and it provides breeding habitat during the summer for several species (including the endangered California least tern (*Sterna antillarum browni)* and threatened western snowy plover (*Charadrius alexandrinus nivosus)*). Habitat types in contact with tidal waters (and potentially spilled oil) in San Francisco Estuary include open water, rocky shore, intertidal mudflats, and tidal marshes. Each has a characteristic fauna.

The avifauna of open water includes loons and grebes, pelicans and cormorants, gulls and terns, and a variety of waterfowl including ducks and scoters. The San Francisco Bay region has been identified as one of 34 waterfowl habitat areas of major concern in the North American Waterfowl Management Plan (USFWS 1989). More than 30 species of waterfowl are found in the San Francisco Bay ecosystem (Goals Project 1998). Mid-winter surveys from 1998 to 2000 found scaup (*Aytha sp.)* comprise 43.2 percent of all waterfowl in the entire San Francisco Estuary, 64 percent of all waterfowl on open water in South Bay, and 67 percent of all waterfowl on open water in Central Bay (URS 2002). The second most abundant waterfowl in San Francisco Bay were scoters, which accounted for 25 percent of the waterfowl in South Bay and 29 percent of the waterfowl in Central Bay.

Rocky shores provide foraging habitat for turnstones and oystercatchers, and roosts for cormorants, pelicans, gulls, and terns. Intertidal mudflats are predominantly populated by shorebirds, and the mudflats of San Francisco Bay are of critical importance in the winter as feeding/staging areas for migrating shorebirds on the Pacific Flyway. The San Francisco Bay estuary is used by over one million shorebirds during spring migration and is home to several hundred thousand during winter (Hui et al. 2001). A recent study of shorebird abundance and distribution on the Pacific Coast of the United States found that San Francisco Bay accounted for many more shorebirds than any other wetland in all seasons (Page et al. 1999). Most shorebird use occurs in the southern reach of the estuary (South Bay) (Hui et al. 2001). Tidal salt and brackish marshes provide essential habitat to support clapper and black rails (*Rallus longirostris obsoletus* and *Laterallus jmaicensis conturniculus*), herons and egrets, the salt-marsh yellowthroat (*Geothlypis trichas sinuosa*), and saltmarsh song sparrows (*Melospiza melodia*).

Three species of marine mammals can be included in the resident fauna of the San Francisco Bay region: the harbor porpoise (*Phocoena phocoena*), the harbor seal (*Phoca vitulina*), and the California sea lion (*Zalophus californianus*). Gray (*Eschrichtius robustus*) and humpback whales (*Megaptera novaeangliae*) may occasionally wander into the Bays but typically live off the open coast. Visits of these species have occurred in recent years as migrating animals strayed into the Bays during coastwise migration in the winter/spring (gray whales) or fall (humpback whales).

<u>Introduced Species</u>

Over 230 non-native species have become established in the San Francisco estuary (Cohen 1998). Exotic species dominate many of the estuary's aquatic assemblages, including soft bottom benthic communities, fouling communities, brackish-water zooplankton in the northern reach, and freshwater fishes. In these communities, introduced species may account for 40 to 100 percent of the common species, up to 97 percent of the total organisms, and up to 99 percent of the biomass (Cohen 1998). Furthermore, the rate of invasions has been increasing. About half of the exotic species identified in the San Francisco estuary were first recorded within the last 35 years. The rate of invasions has increased from about one new species established every 55 weeks between 1851 and 1960 to one new species established every 14 weeks from

1961 to 1995 (Cohen 1998). Some of these invasions have greatly altered habitat structure and nutrient and contaminant pathways. In addition, introduced species have contributed to reductions and extinctions of native species through predation, competition, and the introduction of parasites (San Francisco Estuary Project 1997).

The Asian clam (*Potamocorbula amurensis*) is an example of a species that was recently introduced to the detriment of the natural ecosystem. This euryhaline clam, first collected in 1986, appears to have been introduced as larvae in the seawater ballast of cargo vessels (Carlton et al. 1990). Within 2 years, it spread throughout the estuary, where it reached densities in some areas of over 10,000 individuals per square meter. Nichols et al. (1990) suggest that the Asian clam may have permanently displaced the native benthic community in parts of Suisun Bay. In addition, overgrazing by these large populations of the Asian clam appears to have decimated the phytoplankton in Suisun Bay (Cohen and Carlton 1995, Thompson 2000, San Francisco Estuary Project 1997). Conservative estimates of grazing rates suggest that this clam population is capable of filtering the water column one to two times per day in the shallow waters of Suisun Bay. Asian clams also consume young stages of copepods and compete with mysid shrimp and other zooplankton species for food. Several small crustaceans, including copepods and mysid shrimp, declined sharply in abundance and range following the spread of the clam (San Francisco Estuary Project 1997).

Two recently introduced crab species, the green crab (*Carcinus maenas*) and the Chinese mitten crab (*Eriocheir sinensis*), also pose a threat to the ecosystem. The green crab, a native of the European Atlantic coast, was first collected in San Francisco Bay in 1989 to 1990 (Cohen et al. 1995). It has become abundant in intertidal and shallow subtidal areas and has spread throughout Central Bay, South Bay, and San Pablo Bay to Carquinez Strait. It may have arrived in ballast water, on ship hulls, amongst algae with imported live bait or lobsters, or by intentional release. The green crab is a voracious predator that has been documented to have reduced bivalve populations in New England and Europe (Cohen et al. 1995). Competition with the green crab for food resources could affect shorebirds and possibly the Dungeness crab (San Francisco Estuary Project 1997).

The Chinese mitten crab was first collected in south San Francisco Bay in 1992 and has since spread rapidly throughout the estuary (Veldhuizen and Hieb 1998). It was collected in San Pablo Bay in 1994 and Suisun Marsh and the Delta in 1996. In 1996, a total of 45 mitten crabs were collected from the Delta, Suisun Bay, and Suisun Marsh. By 1997, the number of mitten crabs captured in the Delta rose to over 20,000. The most probable mechanism of introduction in California was either deliberate release to establish a fishery or accidental release via ballast water. The high density of mitten crab burrows in steep banks could accelerate bank erosion and slumping and threaten the structural integrity of levees in the Delta (San Francisco Estuary Project 1997). The mitten crab may also have profound effects on other species through competition (Veldhuizen and Hieb 1998).

The invasive burrowing isopod *Sphaeroma quoyanum* increases erosion in salt marshes by excavating dense burrow complexes along the banks of salt marsh channels (Talley et al. 2001). This species was introduced to San Francisco Bay, probably from the hulls of wooden ships, in the late nineteenth century.

Invasions of non-native species includes microorganisms. The Japanese foraminifer *Trochammia hadai* was first found in San Francisco Bay in sediment samples taken in 1983 and since 1986 has been collected at 91 percent of the sampled sites in the Bay, constituting up to 93 percent of the foraminiferal assemblage at individual sites (McGann et al. 2000). The proliferation of *T.hadai* in San Francisco Bay is associated with a decline in relative abundance of one of the most common native foraminifers *Elphidium excavatum. T.hadai* probably was transported from Japan in ships' ballast tanks, in mud associated with anchors, or in sediments associated with oysters imported for mariculture. Its remarkable invasion of San Francisco Bay suggests the potential for massive, rapid invasions by other marine microorganisms (McGann et al. 2000).

Exotic species have been introduced to the San Francisco estuary by deliberate fish introductions, in imported oyster cultures, from ship hulls, and by ballast water discharges. While the former mechanisms were important in the past, in recent years ballast water discharges are thought to be the primary means through which exotic species become established in the Bay (Cohen 1998). Of the exotic species that were first reported in the estuary in 1986 to 1995, between 47 and 77 percent arrived in ballast water.

Ships take up ballast water when their cargo is unloaded, fuel is consumed, extra stability is needed due to heavy seas, or the ship is too tall to pass under a bridge. The weight of the water taken into a ship's holds lowers the vessel's profile and makes it more stable. When the ship takes up ballast, organisms in the water, mud or nearby pier pilings get pumped into the ships hold along with the water. When the ship reaches its destination, it may discharge the ballast in the port. Organisms stored in the holds are released to the new port where they may thrive.

Between 2.5 and 5 billion gallons of ballast water are estimated to be discharged to the San Francisco estuary per year (Cohen 1998). The average volume of ballast water discharged by tankers in the estuary has been estimated to be about 2.5 million gallons per tanker.

Sampling of organisms in ship ballast water suggests that densities between 0.1 and 1 relatively large planktonic organisms per gallon and greater densities of smaller organisms may frequently be present in ballast water at the conclusion of a transoceanic voyage (Cohen 1998). Because the number and diversity of organisms decline substantially over the duration of a voyage, ships that travel shorter distances, such as most of the tankers servicing the Shore terminal, would have greater densities. Given the large capacity of ship's ballast water pumps, a single deballasting ship may therefore discharge into the environment millions of exotic phytoplankton and invertebrate zooplankton per hour, and larger numbers of protists, bacteria, and viruses.

The National Invasive Species Act was passed in 1996. This act prescribed mandatory regulations for the Great Lakes and Hudson River and added voluntary guidelines for the rest of the country.

The California Ballast Water Management for Control of Nonindigenous Species Act was passed in 1999. This Act prescribes mandatory legislation for the waters of the state of California designed to reduce the introduction of invasive nonindigenous species to California waters.

Although ballast water discharges are probably responsible for the greatest number of non-indigenous species introduced to San Francisco Bay, recent data indicate ship fouling has a higher potential for exotic species introduction than previously believed (Brancato 1999). Reports from Germany and Australia found over 400 invasive species that were introduced in waters directly from the fouled hulls of ships. About one third of the exotic marine species in Australia harbors were determined to have been introduced via hull fouling. In the Pacific Northwest and San Francisco Bay, the European green crab is a major nuisance species believed to have come from accumulated fouling on the hulls of ships.

Rare/Threatened/Endangered Species

Sensitive Plants

Listed plant species that occur in tidal wetlands in the San Francisco Bay region are presented in Table 3.3-1. Sensitive species associated with nontidal wetlands, such as vernal pools, are not included in this summary because they would not be impacted by the continued operation of the Shore marine terminal. The following section provides information on specific habitats, life history, and locations of the sensitive plants listed in Table 3.3-1.

Distributions of known sensitive plant populations in the study area within 250 feet (horizontal distance) of the shoreline were evaluated, based on records in the California Natural Diversity Database (CNDDB). This horizontal distance was used as a study limit under the presumption that it encompasses elevations up to a maximum of about +7 feet mean sea level (MSL) and thus includes all listed plant species that could be affected by a project related oil spill. In addition to the CNDDB records, there are a number of sensitive plant sites reported in Volume II of the Area Contingency Plan (USCG and OSPR 2000). The following text summarizes both the CNDDB and Contingency Plan data.

Table 3.3-1
Special Status Plant Species of
Tidal Marshes of the San Francisco Bay Region*

Common Name/Scientific Name	Status		Habitat
	State	Federal	
Marsh sandwort *Arenaria paludicola*	E	E	Fresh, Salt, and brackish marshes
Suisun thistle *Cirsium hydrophilum* var. *hydrophilum*	--	E	Brackish Marshes
Soft bird's beak *Cordylanthus mollis* ssp. *mollis*	R	E	Salt and brackish marshes
California seablite *Suaeda californica*	R	E	Salt marshes
Mason's lilaeopsis *Lilaeopsis masonii*	R	--	Brackish marshes

Federal Status (determined by USFWS)
E = Federally listed, endangered
State Status
T = State listed, threatened
E = State listed, endangered
R = State listed, rare
*** Sensitive plant species in San Francisco Estuary that are on California Native Plant Society lists but no federal or State lists include Suisun marsh aster (*Aster lentus*), Delta tule pea (*Lathyrus jepsoni* var *jepsoni*), and Delta mudwort (*Limosella sublata*)**
Sources: CDFG 2002.

Tidal habitats of San Francisco Estuary support five plant species that are on federal and/or state lists as threatened, endangered, or rare: California seablite (*Suaeda californica*), marsh sandwort (*Arenaria paludicola*), Mason's lilaeopsis (*Lilaeopsis masonii*), soft bird's beak (*Cordylanthus mollis* ssp. *mollis*), and Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*). All of these species occur in marsh communities at various locations in the estuary, primarily around Suisun Bay and its tributary sloughs. In general, all marsh habitat in the Bay region can be considered actual or potential habitat for federally and/or state-listed threatened, endangered, or rare plant species, or species considered as such by the California Native Plant Society (CNPS).

Suisun Thistle (*Circium hydrophilum* var. *hydrophilum*)

This perennial herb is found in brackish marshes and in peaty soils around Suisun Bay in Solano County. It flowers from July through September. It is a federal endangered species and a CNPS 1B species. According to the CNDDB (CDFG 2002), this plant occurs in the Suisun Marsh near Grizzly Island. Dominant species associated with the Suisun thistle were bulrushes, cinquefoil (*Potentilla* sp.), and rushes.

Soft Bird's Beak (*Cordylanthus mollis* ssp. *mollis*)

This branched annual is found in the coastal salt and brackish marshes of the San Francisco Bay region. It flowers from July to November. It is a State Rare species, Federal Endangered species, and a CNPS 1B species. According to the CNDDB, several populations occur in San Pablo Bay, including the Tule Slough on the Petaluma River, in northern San Pablo Bay near Tubbs Island, in the upper Napa River marsh, and on the southern edge of San Pablo Bay east of Pinole Point. Several populations are found on the north side of the Carquinez Strait at Benicia, and in the Montezuma and Suisun Sloughs north of Grizzly Bay, and in the Shore Acres area in south Suisun Bay (CDFG 2002). Dominant species associated with the soft-haired bird's beak include saltgrass (*Distichlis spicata*), pickleweed (*Salicornia virginica*), Jaumea (*Jaumea carnosa*) and, occasionally, bulrushes.

Mason's Lilaeopsis (*Lilaeopsis masonii*)

This low, tufted perennial inhabits marshes and brackish flats made up of moist sand and mud in Solano County. It flowers from June through August. It is state-listed as rare, and is a CNPS 1B species. According to the Natural Diversity Data Base, populations range from the Napa River above the salt evaporators, north of San Pablo Bay, to the northern reaches of the Suisun and Montezuma Sloughs north of Grizzly Bay, with a majority of the populations found at the convergence of the Sacramento and San Joaquin Rivers, including Brown's Island and the lower Sherman Marsh and throughout the Delta, with populations extending up both the San Joaquin and Sacramento Rivers (CDFG 2002). It extends west as far as Mare Island. Populations also occur along the shore of Peyton Slough (Bullhead Marsh), in the immediate project vicinity (URS 2002b).

California Seablite (*Suaeda californica*)

California seablite is state rare and federal endangered. It is a low-growing, evergreen, perennial shrub with fleshy leaves, in the goosefoot family (Chenopodiaceae). Occurrence records indicate a general association with coastal saltmarshes, but the description of its precise habitat seems to vary depending on what taxonomic reference is consulted. Collectively, the available information suggests that the species favors the upper saltmarsh zone and possibly the drier, sandy upland substrate that may be present above this zone. The reported elevation limit of the species is 4.5 meters (15 feet) MSL. It has been recorded in South Bay marshes and in the Delta.

Marsh Sandwort (*Arenaria paludicola*)

Marsh sandwort was listed by the CDFG as endangered in February 1990, and by the USFWS as endangered on August 3, 1993. It is a perennial, low-growing shrub in the pink family (Caryophyllaceae). The species has been observed most frequently in saltmarsh habitats and less frequently in freshwater marshes. It flowers between May and August. It has been found in the west Central Bay near the Golden Gate.

Other Sensitive Plant Species

Plant species considered sensitive by the CNPS but not on state or federal lists that occur in tidal marshes in San Francisco Estuary include Suisun marsh aster (*Aster lentus*), Delta tule pea (*Lathyrus jepsoni* var *jepsonii*), and Delta mudwort (*Limosella sublata*). Suisun marsh aster and Delta tule pea are CNPS 1B species and Delta mudwort is a CNPS Category 2 species. Species designated as 1B by the CNPS are plants that are rare, threatened or endangered in California or elsewhere. List 2 plants are rare, threatened, or endangered in California but are more common elsewhere.

Suisun marsh aster occurs in brackish and freshwater marshes in Suisun Bay, the western Delta, and Carquinez Strait (CDFG 2002). It was observed near the Shore terminal pier during the 2002 reconnaissance survey of the project site. Delta tule pea tule pea occurs in freshwater and brackish marshes, primarily in the Delta. It has been recorded in a number of locations in Suisun Bay and Carquinez Strait (CDFG 2002). Delta mudwort is found along the margins of channels and sloughs in the Delta area. Within San Francisco Bay it has been recorded in Montezuma Slough (CDFG 2002).

Sensitive Fishes

Table 3.3-2 lists fish species in San Francisco Bay that appear on CDFG and/or USFWS species lists as endangered, threatened, a candidate for endangered or threatened, or a species of special concern.

<u>River Lamprey (*Lampetra ayresi*)</u>

River lampreys have been collected from large coastal streams from Alaska to San Francisco Bay (Moyle 2002). They are most abundant in the Sacramento-San Joaquin River systems but also occur in a number of other tributaries to San Francisco Bay. River lampreys are anadromous, but apparently spend only 3 to 4 months in salt water. River lampreys feed on a variety of fishes, most commonly herring and salmon. They typically attach to the back of the host fish where they feed on muscle tissue. The river lamprey is a California Species of Special Concern.

<u>Delta Smelt (*Hypomesus transpacificus*)</u>

The Delta smelt is one of the few remaining native species found in the upper reaches of San Francisco Bay and the Delta (Monroe and Kelly 1992). Its range extends from around Isleton on the Sacramento River and Mossdale on the San Joaquin River downstream to Suisun Bay. During periods of high river flow, some individuals are washed into San Pablo Bay, but they do not establish permanent populations there. Delta smelt are considered environmentally sensitive because they only live 1 year, have a limited diet, and reside primarily in the interface between salt and fresh water. The legally defined critical habitat of Delta smelt includes the Delta, Suisun Bay, and Suisun Marsh.

Since 1980, the Delta smelt population has generally declined. Numbers of this species now seem to be critically low. The Delta smelt has been listed as threatened by both the federal government and the state of California.

After a period of extremely low populations throughout the 1980s, Delta smelt abundance increased in 1993 to the sixth-highest recorded population index in a 28-year record. This increase apparently was in response to an increase in available habitat brought about by a wet winter and spring, which ended a 7-year drought

Table 3.3-2
Special Status Fish Species of San Francisco Bay

Common Name/Scientific Name	Status		Habitat/Critical Habitat
	State	Federal	
River Lamprey *Lampetra ayresi*	CSC	--	Open water of Delta, Suisun Bay/NA
Delta smelt *Hypomesus transpacificus*	T	T	Open water of Delta, Suisun Bay/Suisun Bay into Delta
Longfin smelt *Spirinichus thaleichthys*	CSC	--	Open water of Bay and Delta/NA
Chinook salmon *Oncorhynchus tshawytscha* Winter run	E	E	Open water of Delta-nursery, migration; Bay-migration/San Francisco Bay north of San Francisco-Oakland Bay Bridge
Chinook salmon *Oncorhynchus tshawytscha* Spring run	T	T (Proposed E)	Open water of Delta-nursery, migration; Bay-migration/Under development
Chinook salmon *Oncorhynchus tshawytscha* Central Valley fall/late fall run	--	Proposed T	Open water of Delta-nursery, migration; Bay-migration/NA
Coho salmon *Oncorhynchus kisutch*	E	T	May be found in some tributary streams to the Bay/NA
Steelhead *Oncorhynchus mykiss* Central California Coast ESU	--	T	Open water of Bay in migration, streams along San Francisco and San Pablo Basins/San Francisco Bay west of Golden Gate Bridge
Steelhead *Oncorhynchus mykiss* Central Valley ESU	--	T	Open water of Bay in migration, Sacramento and San Joaquin Rivers and their tributaries/ Under development
Tidewater goby *Eucyclogobius newberryi*	T	Delisted	Brackish water of lagoons and lower stream reaches/NA
Sacramento splittail *Pogonichthys macrolepidotus*	CSC	T	Brackish and freshwater sloughs of lagoons of Delta Suisun Marsh, Suisun Bay/NA

Federal Status (determined by USFWS)
E = Federally listed, endangered
T = Federally listed, threatened State Status
CSC = California Species of Special Concern
T = State listed, threatened
E = State listed, endangered

(San Francisco Estuary Project 1997). In 1994, however, the Delta smelt population again declined to the low numbers recorded in the 1980s. Abundance rose again in 1995 to the seventh-highest index on record but again declined to historical lows in 1996, despite good habitat conditions in Suisun Bay. The 1997 Delta smelt abundance was low to average and 1998 was relatively low (CDFG 2000). In summary, from 1992 to 2000, numbers of Delta smelt were generally low but were within historical levels for most of those years (Moyle 2002). As of 1999, the CDFG listed the status of Delta smelt as stable to declining (CDFG 2000).

Longfin Smelt (*Sprinchus thaleichthys*)

Adult longfin smelt are broadly distributed throughout the Bay, but use the river channels of the Delta for spawning. Longfin smelt have definite seasonal migrations. They spend early summer in Central and San Pablo Bays, move into Suisun Bay in August and, in winter, congregate for spawning at the upper end of Suisun Bay and in the lower reaches of the Delta (Moyle and Yoshiyama 1992). Longfin smelt populations in San Francisco Bay have declined during the last decade. Although longfin smelt are widely distributed in Pacific coast bays and estuaries, only two populations are known from California: (1) in the San Francisco Bay estuary, and (2) in Humboldt Bay and the Eel River (Moyle and Yoshiyama 1992). Longfin smelt abundance in the San Francisco estuary reached an all-time low in 1992 following 6 years of drought (San Francisco Estuary Project 1997). There is a strong positive relationship between freshwater outflow during the spawning and larval periods and the subsequent abundance of longfin smelt. Moderate outflow in 1993 resulted in a modest population rebound. In 1995, sufficient spawning stock and high outflow led to very good survival and returned the population to predrought abundance levels. Despite reasonably good outflow in 1995-1999 longfin smelt numbers remained fairly low when a stronger upward trend might have been expected (Moyle 2002). Voracious filtering of the base of the food web by the introduced Asian clam and the subsequent decline in the zooplankton prey of longfin smelt is probably a factor in the failure of the smelt population to increase substantially during the 1995 to 1999 wet period (Moyle 2002). Although population levels increased throughout the late 1990s with increased freshwater outflows, the longfin smelt population in San Francisco Estuary is not considered to be fully recovered (Sweetnam et al. 2001). The longfin smelt is both a federal and state species of concern.

Chinook Salmon (*Oncorhynchus tshawytscha*)

After maturing in the ocean, adult Chinook salmon migrate through the San Francisco estuary to spawn in the streambed gravels of the Sacramento River and its tributaries and in the San Joaquin River tributaries (Monroe and Kelly 1992). There are four genetically distinct runs designated by the season in which they enter fresh water to spawn: a fall run that enters fresh water during July through November and begins spawning in October, a late-fall run that moves upstream during October through February and begins spawning in January, a winter run that moves upstream during January through June and begins spawning in April, and a spring run that moves upstream during March through July and begins spawning in August. Although the size of each of the four Chinook salmon runs has fluctuated since the mid-1960s, and although all four runs have declined in the 1980s, the Sacramento River winter run has exhibited the most steady decline. By 1991, fewer than 200 fish were estimated to return to the river to spawn in this run (Monroe and Kelly 1992). The winter run is considered to be at a critically low level and is listed as endangered under the Endangered Species Act and as endangered under the California Endangered Species Act. The return of 1,361 winter-run fish in 1995 and 900 in 1996 was a significant increase over the 1994 all-time low of 189 fish (San Francisco Estuary Project 1997). Spawning populations between 1998 and 2000 numbered between 1,400 and 3,200 fish indicating some recent recovery (Boydstun et al. 2001).

The spring run has also declined markedly since the mid-1980s. The spring run of Chinook salmon is listed as threatened by the state and federal governments and has been proposed by the federal government for listing as endangered. Spring-run abundance averaged 13,000 between 1967 and 1991, but recent populations in several Sacramento River tributaries are at low levels (San Francisco Estuary Project 1997). Spawning populations increased during the late 1990's (Boydstun et al. 2001).

The Central Valley fall/late fall run Evolutionarily Significant Unit (ESU) was proposed by the federal government for listing as threatened in 1998. Sacramento fall-run Chinook salmon remain the most abundant and ubiquitous Chinook stock, and the 1996 return of 212,000 was a significant increase over the previous 6 years (San Francisco Estuary Project 1997). San Joaquin fall-run Chinook returns in 1996 remained far below the 1967-1991 average return of 21,000. Central Valley fall/late fall run abundance increased significantly between 1996 and 2000 (Boydstun et al. 2001).

Coho Salmon (*Oncorhynchus kisutch*)

Coho salmon are widely distributed in streams along the Northern and Central California coast (Moyle and Yoshiyama 1992). In California, principal populations are found in the Klamath, Trinity, Mad, Noyo, and Eel Rivers, as well as in smaller coastal streams south to Scott Creek and Waddell Creek in Santa Cruz County. Currently, there are probably less than 5,000 wild Coho salmon spawning in California each year, and many populations have fewer than 100 individuals. The decline in Coho salmon is probably related to a number of factors, including the degradation of coastal streams, the catastrophic effects of floods and drought on an already declining population, the introgression of genetic integrity by planting of hatchery fish, introduced diseases, and overharvesting. Coho salmon are principally found outside the San Francisco Bay estuary, but small numbers may be found in the San Francisco estuary tributary streams (Herbold et al. 1991). There was a small population using Corte Madera Creek, but it is believed to be gone now (Moyle 2002). A 1994 – 1997 survey of native fishes in streams of the San Francisco estuary did not collect any Coho salmon (San Francisco Estuary Project 1997).

Steelhead (*Oncorhynchus mykiss*) – Central California Coast ESU, Central Valley ESU

Steelhead are anadromous rainbow trout, hatching in fresh water, descending to the sea, and returning to fresh water to spawn. The Central California Coast ESU was listed as threatened by the federal government in 1997. This ESU includes coastal basins from the Russian River south to Soquel Creek, and streams of the San Francisco and San Pablo Bay Basins. The Central Valley ESU was listed as threatened by the federal government in 1998. This ESU includes steelhead that spawn in the Sacramento and San Joaquin Rivers and their tributaries.

Currently, small steelhead runs occur in the South Bay in San Francisquito Creek, Steven's Creek, the Guadalupe River, Coyote Creek, and Permanente Creek; in the East Bay, possibly in Alameda and San Lorenzo Creeks; in the Central Bay in Corte Madera, Miller, Arroya Corte Madera Del Presidio, and Novato Creeks; and in the North

Bay in the Petaluma River, Sonoma Creek, and the Napa River drainage (San Francisco Estuary Project 1997). Steelhead may still occur in Wildcat Creek and the Pinole River in southeast San Pablo Bay. Tributaries to Suisun Bay that support steelhead runs include the Sacramento and San Joaquin Rivers, and Green Valley, and Suisun and Walnut Creeks. Steelhead adults and juveniles may be found foraging in and migrating through estuarine subtidal and riverine tidal habitats within all areas of the San Francisco estuary.

Tidewater Goby (*Eucyclogobius newberryi*)

The tidewater goby is endemic to California and lives in the brackish water habitats from Southern California to the Smith River, Del Norte County (Moyle et al. 1989). This species is found in shallow lagoons and lower stream reaches where the water is brackish (salinities usually less than 10 ppt) to fresh. In the past, tidewater gobies were distributed in brackish water habitats around Central Bay and San Pablo Bay. However, in San Francisco Bay and associated streams, at least 9 out of 10 previously identified populations have disappeared, and a 1984 survey of streams of the Bay drainages did not record any populations (Moyle et al. 1989). A 1994 to 1997 survey of San Francisco estuary streams also failed to record any tidewater gobies (San Francisco Estuary Project 1997). The tidewater goby is listed by California as a threatened species. The tidewater goby population north of Orange County was proposed for delisting by the federal government in 1999.

Sacramento Splittail (*Pogonichthys macrolepidotus*)

The Sacramento splittail is a California Central Valley endemic and was once distributed in lakes and rivers throughout the Central Valley (Moyle et al. 1989). Splittail are now largely confined to the Delta, Suisun Bay, Suisun Marsh, Napa Marsh, the lower Petaluma River, and other parts of the Sacramento-San Joaquin estuary (Moyle 2002). Suisun Marsh has a particularly high concentration of splittail. Splittail are primarily freshwater fish but they can tolerate moderate salinities and can live in water with salinities as high as 10 to 12 ppt. The abundance of this species in the Delta system is strongly tied to outflows because spawning occurs over flooded vegetation. About a month of flooding during the spring spawning period is necessary for incubation, growth, and successful larval emigration from floodplains. When outflows are high, reproductive success is high; when outflows are low, reproduction may fail. Splittail abundance in the San Francisco estuary was poor through most of the drought but improved substantially in 1995 and again in 1998 when good outflow conditions led to very large year classes (Moyle 2002). The Sacramento splittail is federal threatened and a California Species of Special Concern.

Sensitive Birds, Mammals, Reptiles, and Amphibians

There are 38 listed species of birds, 6 species of mammals, and 5 species of amphibians or reptiles that occur or have occurred in habitats vulnerable to oil spills (Table 3.3-3). Oil spills or other impacts would be most damaging to these species because they already have small or isolated populations persisting in an altered

Table 3.3-3
Species of Birds, Mammals, Reptiles, and Amphibians of Special Status on Federal and State Lists that Inhabit Open Waters, Rocky Shore, Mudflats, and/or Tidal Marshlands of the San Francisco Bay Estuary

Common Name/Scientific Name	Status*		Habitat/Critical Habitat
	State	Federal	
Birds			
Common loon *Gavis immer*	CSC	--	Open water
American white pelican *Pelecanus erythrorhynchos*	CSC	--	Open water
California brown pelican *Pelecanus occidentalis californicus*	SE	FE	Open water
Double-crested cormorant *Phalacrocorax auritis*	CSC	--	Open water, rocky shore, tidal marshes
Least bittern *Ixobrychus exilis*	CSC	--	Tidal marshes
White-faced ibis *Plegadis chihi*	CSC	--	Tidal brackish/freshwater marshes
Aleutian Canada goose *Branta canadensis kucoparcia*	--	FT	Open water, tidal brackish/ freshwater marshes
Fulvous whistling duck *Dendrocygna bicolor*	CSC	--	Tidal brackish marshes
Barrow's goldeneye *bucephala islandica*	CSC	--	Open water and tidal brackish marshes
Osprey *Pandion haliaetus*	CSC	--	Open water
Northern harrier *Circus cyaneus*	CSC	--	Tidal marshes
Sharp-shinned hawk *Accipiter striatus*	CSC	--	Tidal brackish/freshwater marshes
Cooper's hawk *Accipter cooperii*	CSC	--	Tidal brackish/freshwater marshes
Ferruginous hawk *Buteo regalis*	CSC	--	Tidal brackish/freshwater marshes
Bald eagle *Haliaeetus leucocephalus*	SE	--	Open water, tidal brackish/ freshwater marshes
Golden eagle *Aquila chrysaetos*	CSC	--	Tidal marshes
Merlin *Falco columbarius*	CSC	--	Tidal brackish/freshwater marshes
American peregrine falcon *Falco peregrinus anatum*	SE	--	Tidal marshes
Prairie falcon *Falco mexicanus*	CSC	--	Tidal freshwater marshes
Yellow rail *Coturnicops noveboracensis*	CSC	--	Tidal marshes
California black rail *Laterallus jamaicensis conturniculus*	ST	--	Tidal saltmarshes
California clapper rail *Rallus longirostris obsoletus*	SE	FE	Tidal saltmarshes
Greater sandhill crane *Grus Canadensis tabida*	ST	--	Tidal brackish/freshwater marshes
Western snowy plover *Charadruis alexandrinus nivosa*	CSC	FT	Intertidal mudflat

Table 3.3-3 (Continued)
Species of Birds, Mammals, Reptiles, and Amphibians of Special Status on Federal and State Lists that Inhabit Open Waters, Rocky Shore, Mudflats, and/or Tidal Marshlands of the San Francisco Bay Estuary

Common Name/Scientific Name	Status*		Habitat/Critical Habitat
	State	Federal	
Long-billed curlew *Numenius americanus*	CSC	--	Intertidal mud, tidal marshes
California gull *Larus californicus*	CSC	--	Open water, intertidal mud, tidal marshes
Elegant tern *Sterna elegans*	CSC	--	Open water, rocky shore, intertidal mudflat
California least tern *Sterna antillarum browni*	SE	FE	Open water, tidal saltmarshes
Marbled murrelet *Brachyramphus marmoratus*	SE	FE	Open water
Burrowing owl *Athene cunicularia*	CSC	--	Tidal salt/brackish marshes
Long-eared owl *Asio otus*	CSC	--	Tidal marshes/upland grass lords
Short-eared owl *Asio flammeus*	CSC	--	Tidal marshes
Black swift *Cypseloides niger*	CSC	--	Rocky shore
Saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	CSC	--	Tidal saltmarshes
Alameda song sparrow *Melospiza melodia pusillula*	CSC	--	Tidal saltmarshes
Suisun song sparrow *Melospiza melodia maxillaris*	CSC	--	Tidal saltmarshes
San Pablo song sparrow *Melospiza melodia samuelis*	CSC	--	Tidal saltmarshes
Tricolored blackbird *Agelaius tricolor*	CSC	--	Tidal brackish/freshwater marshes
Mammals			
Saltmarsh wandering shrew *Sorex vagran halicoetes*	CSC	--	Tidal marshes
Suisun ornate shrew *Sorex ornatus sinuosus*	CSC	--	Tidal marshes
Saltmarsh harvest mouse *Reithrodontomys raviventris*	SE	FE	Tidal salt/brackish marshes
San Pablo vole *Microtus californicus sanpabloensis*	CSC	--	Tidal brackish marshes
Humpback whale *Megaptera novaeangliae*	--	FE	Open water
California Amphibians			
Tiger salamander *Ambystoma tigrinum*	CSC	--	Freshwater and brackish marshes
California red-legged frog *Rana aurora draytoni*	CSC	FT	Tidal freshwater marshes
Reptiles			
San Francisco garter snake *Thamnophis sirtalis*	SE	FE	Tidal freshwater marshes
Western pond turtle *Clemmys marmorata*	CSC	--	Tidal freshwater marshes

Table 3.3-3 (Continued)
Species of Birds, Mammals, Reptiles, and Amphibians of Special Status on Federal and State Lists that Inhabit Open Waters, Rocky Shore, Mudflats, and/or Tidal Marshlands of the San Francisco Bay Estuary

***Federal Status (determined by USFWS)**
E = Federally listed, endangered
T = Federally listed, threatened

State Status
CSC = California Species of Special Concern
T = State listed, threatened
E = State listed, endangered

Source: Code of Federal Regulations, Title 50, Parts 17.11 and 17.12 (April 15, 1990) and Annual Notices of Review; USFWS Sensitive Bird Species List; USFWS Migratory Nongame Birds of Management Concern List; CDFG Natural Diversity Data Base, Special Animals, 2002.

environment. Because these species are rare, information on their distribution is often limited to records of sightings at scattered locations. The current status of those species that require or are restricted to open water, rocky shore, intertidal mudflats, or tidal marshes is further described.

Birds

The following species of rare/threatened/endangered birds may be most susceptible to contact by oil spills because of their foraging habits, reliance on intertidal mudflats and tidal saltmarshes for nesting habitat, use of open water, or the known impacts from previous oil spills.

Common Loon *(Gavis immer)*

The common loon's breeding habitat in the western states in limited to Idaho. Winter visitors to San Francisco Bay are found in deeper open water areas.

American White Pelican (*Pelecanus erythrorhynchos*)

The American white pelican is a late summer/fall migrant through the area and a winter visitor. The species nests in large inland lakes in the western states and Canada; only remnant colonies exist in California in the Klamath Basin and Honey Lake area. During fall and winter, white pelicans are locally common in large open water areas, including salt ponds.

California Brown Pelican *(Pelecanus occidentalis californicus)*

The California brown pelican breeds in the spring on islands of the Southern California Bight and Mexico. Following the breeding season, brown pelicans migrate northward. The species reaches its peak abundance in central California in August through September (Briggs et al. 1983). In the Bay, brown pelicans forage over deep open water and roost on many breakwaters and piers and, occasionally, on salt-pond dikes.

Double-Crested Cormorant *(Phalacrocorax auritis)*

This species nests in the San Francisco Bay Area, predominantly on bridges, towers, and other man-made structures. The colony breeding on the San Francisco-Oakland Bridge numbered 465 pairs in 1990, making it the second largest in the state. The cormorant population on the Bay Bridge saw a 71 percent increase from 1990-1999 (American Segmental Bridge Institute 2002). The large colony on the Richmond-San Rafael Bridge had 424 breeding pairs in 1990. In 2000, the Richmond-San Rafael Bridge Colony fledged 433 chicks (Rauzon 2000). Smaller nesting colonies are found at a variety of other sites throughout the Bay (Carter et al. 1992).

California Black Rail *(Laterallus jamaicensis conturniculus)*

The California black rail's habitat of tidal marshes has been greatly reduced and fragmented. The species currently breeds only in San Pablo Bay, Suisun Bay, and the lower Delta. Highest densities of California black rails occur in the Petaluma River Wildlife Management Area, along Black John and Fagan sloughs and Coon Island in the Napa marsh, and in tidal marshes along the shore of San Pablo Bay. This secretive species requires tidal marshes that include higher elevational zones not subject to extreme and frequent tidal action (USFWS 1992). Black rails tend to occur in the larger undiked marshes associated with larger rivers and in some bayshore parcels, particularly those associated with the mouths of rivers and creeks (Nur et al. 1997). Black rail populations in the Bay region have not decreased since 1986 (San Francisco Estuary Project 1997). Black rail surveys in 2001 resulted in population estimates of approximately 15,000 black rails in San Pablo Bay and 12,000 black rails in Suisun Bay (Spautz and Nur 2002). In the 2001 survey, the most rails were heard in San Pablo Bay at Day Island, Black John Slough and nearby Greenpoint Centennial Marsh, Petaluma Marsh and Lower Tubbs Island muted marsh, and in Suisun Bay at Benicia State Park and Rush Ranch. A moderate number of black rails were detected at China Camp, Corte Madera Ecological Marsh, Petaluma Rivermouth, Pond 2A, Fagan Slough, Pt. Pinole, San Pablo Creek Marsh, and in Suisun Bay at Peyton Slough, Hill Slough and Grey Goose. Black rails appear to be absent in Central and South Bays.

California Clapper Rail *(Rallus longirostris obsoletus)*

The California clapper rail is a year-round resident in the San Francisco Bay area where it continues to suffer severe habitat loss due to human encroachment on tidal marshes and predation by red foxes. Preferred habitat is characterized by close proximity to tidal flow (habitat traversed by tidal sloughs), and cover of pickleweed with extensive stands of Pacific cordgrass at lower elevations and gumplant and wrack at higher elevations. California clapper rails feed on mollusks in mud-bottomed sloughs near cover. The population in the San Francisco Bay Area from 1981-1987 was estimated at only about 1,500 birds (Harvey 1988), but declined to fewer than 500 in 1991 (USFWS 1992). The population has rebounded somewhat to about 1,200 in recent years (San Francisco Estuary Project 1997, CDFG 2002). Based on winter counts from 1996 to 1997, the South Bay population was estimated to be 500 to 600 birds and the North Bay population to be a similar size (CDFG 2000), Distribution of California clapper rail habitat from Gill (1979) is shown on Figure 3.3-2.

Figure 3.3-2 Clapper Rail Habitat in San Francisco Bay

California Least Tern *(Sterna antillarum browni)*

The California least tern was listed as endangered on federal and state lists in 1970 because of its small population on drastically reduced nesting habitat. In the Bay Area, the species currently has major nesting effort only at Alameda Naval Air Station and Oakland International Airport in Alameda County. However, peripheral sites also exist where sporadic nesting effort occurs. These sites may be used in 1 year and not the next, but have the potential to become important new colonies (Chambers Group 1994). A PG&E cooling pond in Pittsburg has supported at least two to four pairs in recent years (San Francisco Estuary Project 1997). In 2000, this colony supported 15 pair.

In 1996 a total of 208 pairs of lest terns nested at the Alameda Naval Air Station site and fledged 233 young (San Francisco Estuary Project 1997). This nesting effort was up from 150 pair and 73 young fledged in 1995. In 2000, approximately 300 pair fledged between 200 and 230 young. The Oakland International Airport tern colony has experienced problems in recent years. No nesting occurred from 1992 to 1994 or in 1996 and all of the 1995 nests failed (San Francisco Estuary Project 1997). One reason may be predation by the non-native red fox. California least terns forage near their colonies in eelgrass beds where they are vulnerable to oil spills.

Western Snowy Plover *(Charadruis alexandrinus nivosa)*

In San Francisco Bay, snowy plovers nest almost exclusively on levees and islands of salt ponds and in dry salt ponds of the south Bay (Warriner et al. 1986). A survey in June 1978 resulted in a count of 351 adult birds, but subsequent June counts have been lower (Page and Stenzel 1981; USFWS 1992). Almost all snowy plover nesting occurs in the South Bay. The winter population of snowy plovers numbers at least 350 birds, most of which are found in the vicinity of salt ponds in the Baumberg area of the South Bay (Page et al. 1986). At any time of year, snowy plovers foraging on intertidal mudflats are vulnerable to impacts of oil spills reaching the South Bay. The CNDDB lists western snowy plovers as occurring in San Mateo County near Belmont and Redwood City, and at Bair Island in Alameda County near Hayward (CDFG 2002).

Long-Billed Curlew *(Numenius americanus)*

Long-billed curlews are a wintering shorebird in California and do not breed in the San Francisco Bay Area. They are most abundant in the fall and winter and their numbers decline in the spring when they are on their northern breeding grounds.

American Peregrine Falcon *(Falco peregrinus anatum)*

Peregrine falcons in the San Francisco Bay and Delta prey to some extent on terns, shorebirds, and seabirds. In this part of their range, they forage predominantly in wetlands surrounding the Bay. Because of the possibility of ingestion of oil-contaminated prey or scavenged carcasses, the peregrine falcon and other raptors are at risk of oil spills.

Mammals

<u>Suisun Ornate Shrew *(Sorex ornatus sinuosus)*</u>

The Suisun shrew is an inhabitant of tidal marshes of northern San Pablo and Suisun Bays and, historically, ranged as far east as Grizzly Island and as far west as the mouth of Sonoma Creek, the Petaluma River, and Tubbs Island (Western Ecological Services Company 1986b, as cited in USFWS 1992). The species currently may be found only on Grizzly Island (Williams 1983). Suisun shrews inhabit the middle-to-high marsh elevations where deposited litter and driftwood provide shelter and forage. An important adjunct of habitat is that higher upland areas exist where animals can move during extreme high tides. While some tidal marshes in San Pablo Bay exist with access to higher marshland vegetation, most are broken into small, isolated units with little elevational gradient. Diked marshes may provide suitable cover for these shrews and are more available in Suisun Marsh than elsewhere (Western Ecological Services Company 1986b, cited in USFWS 1992). The CNDDB lists occurrences at Lake Chabot, Sears Point Road northwest of Vallejo, Southampton Bay in Solano County, Suisun City saltmarsh, near Cordelia salt marsh, near Napa River and Highway 37, near White Slough and Highway 37, South and Dutchmans Sloughs, and at Mare Island Naval Shipyard at the mouth of Carquinez Strait (CDFG2002).

<u>Saltmarsh Wandering Shrew *(Sorex vagran halicoetes)*</u>

This species prefers tidal salt marshes with dense cover of pickleweed and sufficient driftwood to provide soil moisture adequate for habitat and invertebrate food resources. It is apparently limited to the southern San Francisco Bay where it inhabits marshes 2 to 3 m above the high water line (Findley 1955). For the purposes of this EIR, the current distribution is defined by past records of observations and captures, including marshes of Santa Clara, Alameda, Contra Costa, San Mateo, and San Francisco Counties (Williams 1986). The CNDDB lists occurrences in the saltmarsh at the west approach to the Dumbarton Bridge, on Bair Island near Redwood Point, in Alameda Creek, at Giant Marsh in Contra Costa County, in San Pablo Creek saltmarsh north of Richmond, at Arrowhead (Melrose) Marsh north of Oakland Airport, at Oakland Airport, at Ravenswood Point in San Mateo County, and at Johnson and Hayward Landings in Alameda County.

<u>Saltmarsh Harvest Mouse *(Reithrodontomys raviventris)*</u>

The saltmarsh harvest mouse is endemic to salt and brackish marshes where its preferred habitat is the higher tidal wetlands that provide access, if necessary, to refugia during extreme high tides (USFWS 1992). The preferred habitat is typically dominated by pickleweed, along with a diverse mixture of vegetation characterizing the transition zone. Saltmarsh harvest mice are also able to use diked marshes and adjacent grasslands during the late spring. Two subspecies exist in the area: the northern, inhabiting San Pablo and Suisun Bays, and the southern, inhabiting central and southern San Francisco Bay. Currently, suitable habitat is only about 5 percent of that historically available, and conservation of the species focuses on habitat protection and restoration. The CNDDB lists occurrences at many sites in saline emergent wetlands of Solano, Contra Costa, Alameda, San Mateo, Marin, Sonoma, and Napa Counties.

San Pablo Vole *(Microtus californicus sanpabloensis)*

San Pablo vole populations are found in three widely isolated fragments in saltmarshes along the south shore of San Pablo Bay in Contra Costa County (Western Ecological Services Company 1986c, cited in USFWS 1992). The CNDDB indicates occurrences in Giant Marsh and adjacent grasslands, San Pablo Creek and associated saltmarsh, and Wildcat Creek and marsh at creek mouth (CDFG 2002).

Humpback Whale *(Megaptera novaeangliae)*

The humpback whale is a federally listed endangered species that feeds in the Gulf of the Farallones in the fall. One individual entered San Francisco Bay in October 1985 and again in October 1990 ("Humphrey"). Sightings of individual whales have been made regularly near the mouth of the Bay (Chambers Group 1994).

Amphibians and Reptiles

The amphibian and reptile fauna of the brackish and freshwater marshes in the San Francisco Bay region includes five species that are listed as rare/threatened/ endangered (or candidate) or California Species of Special Concern (Table 3.3-3). While all may use tidal marshes as habitat, they are not limited to marshes nor are they necessarily present wherever that habitat-type occurs. Because of their rarity, distributional data are limited.

California Tiger Salamander *(Ambystoma tigrinum)*

This species may typically be out of reach of oil spills; found in some brackish freshwater marshes, it more commonly occurs at higher elevations. For survival, it requires vernal pools for breeding and access to rodent burrows for hibernation and estivation (dormant period during the summer) (citations in USFWS 1992). The CNDDB lists its present range to include San Francisquito Creek in San Mateo County.

California Red-Legged Frog *(Rana aurora draytoni)*

The California red-legged frog is rare in the San Francisco Bay region, and has only a few relict populations in surrounding coastal mountains and the Delta. It prefers fresh and brackish marshes and riparian habitats. In the San Francisco Bay region, red-legged frogs are present in the Santa Cruz Mountains, the San Francisco State Fish and Game Refuge in San Mateo County, in canals at the San Francisco International Airport, and in northern Contra Costa County at the Concord Naval Weapons Station, Marsh and Kellogg Creeks, and in the Los Vaqueros area (citations in USFWS 1992). The CDFG Natural Diversity Database also indicates occurrence in Golden Gate Park, the Presidio, and other sites near the city of San Francisco. The USFWS is in the process of designating critical habitat for the California red-legged frog.

San Francisco Garter Snake *(Thamnophis sirtalis)*

The San Francisco subspecies of the common garter snake is listed as endangered (by both the federal and state alternatives). It is known to occur in tidal, (brackish) freshwater marshes but may be more common at higher elevations. It has been recorded in recent years in the San Francisco State Fish and Game Refuge (San Mateo County), near Crystal Springs Reservoir, Sharp Park Golf Course in Pacifica, Mori Point, Cascade Ranch, Sanchez Canyon in Hillsborough, San Francisco International Airport, and in irrigation ponds along the San Mateo coast (USFWS 1992, CDFG 2002).

Western Pond Turtle (*Clemmys marmorata)*

Habitat requirements of the western pond turtle include backwater areas with abundant vegetation, logs for basking, and open sunny slopes well away from riparian zones for egg deposition (USFWS 1992).

3.3.2.3 Project Area

Introduction

This section describes in detail the tidally influenced biological resources of the project area. The project area extends from the Caquinez Bridge (Interstate 80) to just west of Pittsburg and encompasses Carquinez Strait and Suisun Bay. The biological resources subject to tidal inundation within this area would be more vulnerable to an oil spill from operations at the Shore marine terminal than resources located elsewhere in the estuary.

Carquinez Strait is the narrow passage that joins San Pablo Bay on the west to Suisun Bay on the east. The 12-mile long Strait is characterized by deep water habitat (mean depth 29 feet) and a variable salinity regime related to fluctuations in freshwater flow from the Sacramento-San Joaquin River system (Corps, EPA, BCDC, RWQCB and SWRCB 1998).

Suisun Bay is the northeasternmost embayment of San Francisco Estuary. Suisun Bay covers approximately 36 square miles, has a mean depth of 14 feet, and a mean salinity of approximately 7 parts per thousand (ppt) (Corps, EPA, BCDC, RWQCB and SWRCB 1998). Freshwater flowing from the Delta usually meets saltwater from the ocean in the vicinity of Suisun Bay. The entrapment zone of high productivity and ecological importance to many species in the estuary usually is located in Suisun Bay.

Plankton

Historically, Suisun Bay was characterized by high concentrations of phytoplankton (Davis 1982). The Suisun Bay phytoplankton assemblage was dominated by freshwater forms in the winter during periods of high river outflow and by more marine forms, particularly diatoms, during the summer. Peaks in phytoplankton abundance, as measured by chlorophyll *a* concentrations, tend to coincide with the turbidity maximum or entrapment zone, which usually is located near the 2 ppt isohaline. Prior to the late 1980s a diatom bloom occurred in Suisun Bay in summer (July and August) that coincided with the landward movement of marine waters. Peak abundances of invertebrate zooplankton including the copepod *Eurytrema affinis* and the mysid *Neomysis mercedis*, as well as juvenile and larval fishes, appear to correlate with the phytoplankton maximum in the entrapment zone (Kimmerer et al. 1998). It's thought that these organisms have behavioral adaptations to maintain their position in this area of high food abundance (Kimmerer 1998, Bennett 1998).

In recent years, the plankton assemblages of Suisun Bay have changed considerably as a result of introduction of the Asian clam and, to a lesser extent, reduced Delta outflows and direct competition with introduced species. In Suisun Bay, grazing by the Asian clam is suspected of having an overriding influence on phytoplankton biomass, species composition and size structure (Lehman 1998). Since its introduction in 1987, the Asian clam has lowered chlorophyll *a* concentrations in Suisun Bay by a factor of 10. Its ability to remove phytoplankton in channels is a function of high densities that may exceed 6,000 clams per square meter in drought years and high grazing rates that enable it to filter all the water in 10 meter deep channels 1.28 times per day (Lehman 1998). This voracious filtration appears to have reduced the abundance of diatoms, which have a large diameter, and led to the proliferation of small green and bluegreen algae that may persist because they are ineffectively grazed by the Asian clam, which cannot retain very small particles. These very small types of phytoplankton provide inferior food for native zooplankton species, which have decreased since the introduction of the Asian clam.

In addition, to the loss of phytoplankton by grazing of the Asian clam, decreases in phytoplankton abundance in Suisun Bay may be related to variations in river flows (Jassby et al. 1996). Phytoplankton production is greatest when the entrapment zone is over the expansive shoals of Suisun Bay where light levels are high. When river flows are too high or too low the entrapment zone is positioned in deep turbid channels upstream or downstream of these shoals and growth rates are low due to lower light levels.

Changes in phytoplankton biomass, community composition and cell diameter in Suisun Bay may degrade the food web of San Francisco Estuary, because they affect copepod food quantity and quality (Lehman 1998). These changes in quantity and quality of phytoplankton food may have contributed to some of the long-term shifts in copepod species composition and distribution. Densities of the larger copepods have decreased and densities of smaller introduced copepod species have increased. These changes in phytoplankton may have added to the stresses on the declining copepod species *Eurytrema affinis*, which also is thought to have declined because of direct filtering by the Asian clam.

As discussed in the previous section, the opossum shrimp *Neomysis mercedis,* an important food organism for juvenile fishes, has declined in the last two decades. Food limitation because of the reduced phytoplankton concentrations is thought to be the primary reason for the decline (Orsi and Mecum 1996). Competition for food by two introduced Asian mysid shrimp also may hamper the recovery of the native mysid population.

Benthos

The San Francisco Estuary Institute Regional Monitoring Program Benthic Pilot Study sampled benthic invertebrate communities throughout San Francisco Estuary between 1994 and 1997 (Thompson et al. 2000). The study identified three major benthic invertebrate assemblages in the estuary related to the relative amount of marine and freshwater influences: the marine assemblage, the estuarine assemblage, and the fresh-brackish assemblage. The project area was characterized by an assemblage of benthic organisms that was dominated by estuarine species (main estuarine sub-assemblage) and by a sub-assemblage that was transitional between the estuarine assemblage and the fresh-brackish assemblage.

The Benthic Pilot Study had a station (D6) just west of the mouth of Pacheco Creek approximately 1 mile east of the Shore terminal pier. It was sampled 23 times in 1996 and 1997 (Thompson et al. 2000). The number of invertebrate taxa ranged from 2 to 9 per sample. The invertebrate assemblage shifted from main estuarine to estuarine transition depending on the amount of freshwater flow. The main estuarine assemblage is strongly dominated by the Asian clam. An introduced tube building amphipod, A*mpelisca abdita,* also was abundant in this sub-assemblage. The estuarine transition sub-assemblage, like the marine estuarine assemblage, is characterized by the Asian clam, but also includes species characteristic of the fresh-brackish assemblage like the polychaete worm, *Marenzelleria viridis,* and the amphipod *Gammarus daiberi*.

The CDFG samples fishes and invertebrates by otter trawl and midwater trawl throughout San Francisco Bay (Baxter et al. 1999). Station 432 is located on the south side of Suisun Bay west of the mouth of Pacheco Creek, not far from the Shore terminal pier. Table 3.3-4 shows epibenthic invertebrates collected by otter trawl at this station between 1996 and 2000. The most abundant epibenthic invertebrates were California bay shrimp and oriental shrimp. Blacktail bay shrimp, Dungeness crab, and the invasive Chinese mitten crab (*Eriocher sinensis*) were also caught at this station.

Table 3.3-4
Invertebrate Species Collected by Otter Trawl at Station # 432 from 1996-2000

Common Name	Invertebrate Species	1996	1997	1998	1999	2000
blacktail bay shrimp	*Crangon nigricauda*	46	40	31	0	221
California bay shrimp	*Crangon franciscorum*	15,310	28,141	44,028	12,066	12,266
Chinese mitten crab*	*Eriocheir sinensis*	0	8	19	52	28
Dungeness crab	*Cancer magister*	3	19	0	16	18
oriental shrimp*	*Palaemon macrodactylus*	231	775	721	233	224

***Introduced species**
Source: Interagency Ecological Program for the San Francisco Estuary and California Department of Fish and Game's San Francisco Bay Study 2003

Earlier data on benthic invertebrates in the project area are generally consistent with the more recent information. In 1990, Entrix took grab samples of benthic invertebrates at three transects located west of the mouth of Peyton Slough relatively close to the Shore terminal pier (Entrix 1991). The Asian clam was the most abundant species in the samples. The polychaete *Streblospio benedicti* and the cumacean *Leucon subnasica* were the two next most abundant species respectively. They also collected fishes and epibenthic invertebrates by otter trawl. The trawls collected crangonid and oriental shrimp.

During the 1990 study, Entrix also collected invertebrates by grab sample at three stations within Peyton Slough and at one station in the mudflat at the mouth of Peyton Slough (Entrix 1991). Twenty taxa of benthic invertebrates were collected at the four stations. The most abundant species in the slough was the introduced estuarine worm *Streblospio benedicti.* The Asian clam dominated the mudflat station at the mouth of the slough. The Asian clam accounted for 94 percent of the total catch in the mudflat but comprised a relatively low portion of the animals collected within the slough.

Dungeness crabs are fairly common in Suisun Bay during years with low freshwater outflow (Baxter et al. 1999). The introduced Chinese mitten crab has become abundant in the project area in recent years. Shore workers who fish from the Shore Terminals pier report collecting large numbers of this invasive species.

<u>Fishes</u>

This Section describes the characteristics of the fish assemblages in Carquinez Strait and Suisun Bay. Important non-sensitive fish species of the project area are then discussed in greater detail. Sensitive fish species were discussed in the previous section above.

Characteristics of the Project Area

The project area is important to many sensitive fish species as well as to several species of interest to fishermen. Carquinez Strait is an important migratory corridor for many fish species including striped bass, Chinook salmon, American shad, steelhead, Sacramento splittail, Pacific herring, northern anchovy, white sturgeon and longfin smelt. During periods of strong Delta outflow, fresh and brackish water species more characteristic of Suisun Bay move downstream through Carquinez Strait into San Pablo Bay (Baxter et al. 1999). During periods of low freshwater flows marine species move up into Suisun Bay.

Suisun Bay supports a unique fish assemblage as a result of the decreased salinity and the network of sloughs along the edges. Species characteristic of Suisun Bay include longfin smelt, Delta smelt, Pacific staghorn sculpin (*Leptocottus armatus*), northern anchovy, starry flounder (*Platichthys stellatus*) as well as such introduced species as striped bass, American shad, and yellowfin goby (*Acanthogobius flavimanus*). The annual success of a number of fish species is tied to the amount of low salinity water in Suisun Bay as measured by the position of the 2 ppt bottom salinity isohaline

(Moyle 2002). The farther downstream the iohaline, the more likely the young of freshwater and brackish water fishes to have high survival rates. Unfortunately the value of Suisun Bay as a nursery area has been compromised by not only the Asian clam but also invasions of non-indigenous copepods, amphipods, shrimp, crabs and fishes (Moyle 2002).

As mentioned above, the CDFG samples fishes and invertebrates by otter trawl and midwater trawl throughout San Francisco Bay (Baxter et al. 1999). Station 432 is located on the south side of Suisun Bay in the general vicinity of the Shore Terminals pier. Tables 3.3-5 and 3.3-6 show fishes collected at these stations since 1996. The most abundant fishes caught in otter trawls since 1996 were Pacific staghorn sculpin, striped bass, yellowfin goby, and longfin smelt (CDFG 2003). Between 1996 and 2001, 2 Chinook salmon, 1 Delta smelt, and 2 Sacramento splittail were caught in otter trawls at this station. The most abundant fish species caught in midwater trawls were longfin smelt, striped bass, and northern anchovy. Between 1996 and 2001, 20 Chinook salmon, 7 Delta smelt, and 25 Sacramento splittail were caught in the midwater trawls.

Table 3.3-5
Total Number of Each Fish Species Collected by Otter Trawl at Station # 432 from 1996-2001

Common Name	Fish Species	1996	1997	1998	1999	2000	2001
American shad*	*Alosa sapidissima*	0	0	1	0	0	0
arrow goby	*Clevelandia ios*	0	0	0	0	0	1
bay goby	*Lepidogobius lepidus*	1	11	0	11	0	3
California halibut	*Paralichthys californicus*	0	0	0	1	0	0
chinook salmon	*Oncorhynchus tshawytscha*	0	0	1	0	0	1
delta smelt	*Hypomesus transpacificus*	0	0	1	0	0	0
inland silverside*	*Menidia beryllina*	1	0	0	0	0	0
longfin smelt	*Spirinchus thaleichthys*	7	4	15	39	6	4
Pacific lamprey	*Lampetra tridentate*	0	0	0	0	0	2
Pacific staghorn sculpin	*Leptocottus armatus*	30	28	15	50	22	27
Pacific tomcod	*Microgadus proximus*	0	1	0	0	0	0
plainfin midshipman	*Porichthys notatus*	3	8	0	3	0	18
prickly sculpin	*Cottus asper*	0	0	3	0	0	0
river lamprey	*Lampetra ayresi*	0	2	0	1	4	1
shimofuri goby*	*Tridentiger bifasciatus*	7	1	2	1	0	0
Shokihaze goby*	*Tridentiger barbatus*	0	0	1	3	14	12
speckled sanddab	*Citharichthys stigmaeus*	4	8	0	0	0	1
Splittail	*Pogonichthys macrolepidotus*	1	0	0	0	1	0
starry flounder	*Platichthys stellatus*	4	10	6	3	0	0
striped bass*	*Morone saxatilis*	20	6	9	15	6	18
threespine stickleback	*Gasterosteus aculeatus*	1	0	1	0	0	0
white catfish*	*Ameiurus catus*	0	0	1	0	0	0
white sturgeon	*Acipenser transmontanus*	1	0	0	0	0	0
whitebait smelt	*Allosmerus elongates*	0	0	1	0	0	0
yellowfin goby*	*Acanthogobius flavimanus*	6	3	10	19	19	9

*** Introduced species**
Source: Interagency Ecological Program for the San Francisco Estuary and California Department of Fish and Game's San Francisco Bay Study (CDFG 2003).

Table 3.3-6
Fish Species Collected by Midwater Trawl at Station # 432 from 1996-2001

Common Name	Fish Species	1996	1997	1998	1999	2000	2001
American shad*	*Alosa sapidissima*	9	27	6	5	17	29
bay goby	*Lepidogobius lepidus*	0	0	0	0	0	1
chinook salmon	*Oncorhynchus tshawytscha*	4	2	2	4	2	6
common carp*	*Cyprinus carpio*	0	0	0	0	0	5
delta smelt	*Hypomesus transpacificus*	1	0	3	2	1	0
English sole	*Pleuronectes vetulus*	0	0	0	0	1	0
longfin smelt	*Spirinchus thaleichthys*	36	5	215	220	132	45
northern anchovy	*Engraulis mordax*	1	30	28	12	44	80
Pacific herring	*Clupea pallasi*	1	10	0	0	3	11
Pacific staghorn sculpin	*Leptocottus armatus*	1	2	0	4	1	3
plainfin midshipman	*Porichthys notatus*	0	1	1	1	0	0
prickly sculpin	*Cottus asper*	0	0	1	0	0	0
shimofuri goby*	*Tridentiger bifasciatus*	2	1	3	0	2	0
Shokihaze goby*	*Tridentiger barbatus*	0	0	0	0	2	1
splittail	*Pogonichthys macrolepidotus*	11	0	5	5	4	0
starry flounder	*Platichthys stellatus*	3	3	3	0	0	0
striped bass*	*Morone saxatilis*	35	33	26	33	44	26
threadfin shad*	*Dorosoma petenense*	0	0	1	0	4	8
white croaker	*Genyonemus lineatus*	2	6	0	0	1	1
white sturgeon	*Acipenser transmontanus*	3	0	0	1	0	0
yellowfin goby*	*Acanthogobius flavimanus*	2	1	1	3	13	3

*** Introduced species**
Source: Interagency Ecological Program for the San Francisco Estuary and California Department of Fish and Game's San Francisco Bay Study (CDFG 2003).

Earlier fish collections in the vicinity of the Shore terminal were done by Entrix (1991). Entrix collected fishes and benthic invertebrates by otter trawl on the south shore of Carquinez Strait between the Benicia-Martinez Bridge and the mouth of Peyton Slough in 1990. The most abundant fish species they collected was Pacific staghorn sculpin. They also collected plainfin midshipman (*Porichthys notatus)*, yellowfin goby, starry flounder, striped bass and longfin smelt. In June 1988, Entrix conducted otter trawls in the same areas and, again Pacific staghorn sculpin was the most abundant fish species. Other fishes collected in 1988 included speckled sandab (*Citharichthys stigmaeus*), starry flounder, shiner surfperch, green sturgeon, yellowfin goby, prickly sculpin (*Cottus asper*), and brown rockfish (*Sebastes auriculatus*).

The 1990 and 1988 Entrix studies also collected fishes by beach seine on the mudflats at the mouth of Peyton Slough (Entrix 1991). Table 3.3-7 shows the fishes collected in these studies. Topsmelt (*Atherinops affinis*) and striped bass were the most abundant fishes collected in 1990. Pacific staghorn sculpin and topsmelt were the most abundant fishes collected on the mudflat in 1988.

Table 3.3-7
Relative Fish Abundance at Peyton Mudflat
Collected by 50 Foot Beach Seine

Species	1998	1999
Pacific staghorn sculpin	5	0
striped bass	2	4
Topsmelt	4	5
starry flounder	1	0.5
shiner surfperch	1	0
yellowfin goby	1	3
bay goby	2	0
northern anchovy	1	0
white catfish	1	0
Source: Entrix 1991.		

Previous studies also have collected fishes within the channels of Peyton Slough near Shore Terminals (Entrix 1991). Three fish species were caught: striped bass, yellowfin goby and chameleon goby (*Tridentiger trignocephalus*). All of these are introduced species. Chameleon gobies were the most abundant fish species collected.

Earlier fish surveys were done in Peyton Slough in 1986 and 1988 (in Entrix 1991). Peyton Slough was surveyed in 1988 as part of the Shell oil spill studies. Pacific staghorn sculpin was the most abundant fish species in the 1988 otter trawls. Bay gobies (*Lepidogobius lepidus)* also were collected. The 1986 fish surveys in Peyton Slough were dominated by Sacramento splittail and striped bass. Other fish species collected included staghorn sculpin, threespine stickleback (*Gasterosteus aculeatus*), inland silversides (*Menidia beryllina*), and yellowfin goby.

URS (2002) reported that two Chinook salmon smolts were collected in the McNabney Marsh area, which is south of Waterfront Road and connected to Peyton Slough by tide gates, during three years of sampling between 1998 and 2001. In addition, Chinook salmon and Sacramento splittail have been collected in tributaries of Pacheco Creek (Leidy 1999). These observations indicate that sensitive fish species enter sloughs in the vicinity of the Shore terminal.

The north shore of Suisun Bay contains Suisun Marsh with its extensive slough system. The fishes in the various sloughs of Suisun Marsh were studied by Meng, Moyle, and Herbold (1994). Their studies collected 42 species in the sloughs of Suisun Marsh. Fourteen species accounted for 98 percent of the total catch. The most abundant species included five native resident species: prickly sculpin, Sacramento sucker (*Catostomus occidentalis*), Sacramento splittail, threespine stickleback and Tule perch (*Hysterocarpus traski*); five seasonal species: Delta smelt, longfin smelt, Pacific staghorn sculpin, starry flounder, and threadfin shad (*Dorosoma petense*); and four introduced species: chameleon goby, common carp (*Cyprinus carpio*), striped bass, and yellowfin goby.

Although not collected in any of the surveys reviewed here, Central valley steelhead clearly pass through Carquinez Strait and Suisun Bay on their migrations between the ocean and the Sacramento-San Joaquin River system and smolts would be expected at times to use the sloughs on either side of Carquinez Strait and Suisun Bay.

Important Fish Species of the Project Area (see previous section for sensitive species)

<u>Striped Bass (*Morone saxafilis*)</u>

The striped bass was introduced in 1879 and was successful enough to support a commercial fishery until 1935, when commercial fishing was banned. The striped bass spawns in the Sacramento-San Joaquin Rivers at salinities of 0 to 0.5 ppt. At salinities greater than 1 ppt, egg survival declines significantly (Jefferson Assoc. 1987). After spawning, the adults move back downstream to the Bay and ocean where they remain until the following breeding season. Juvenile striped bass migrate downstream to the Delta and the Bay where they remain during their first year. Young fish rearing habitat extends into San Pablo Bay during wet years (CALFED Bay-Delta Program 1998).

The striped bass population has declined significantly in recent years. Hydrological changes in the Delta seem to be the primary cause of this decline (Herbold et al. 1991), but there may be other factors, such as the accumulation of toxic contaminants and reduction of the larval food supply. In 1996, some of the lowest abundances ever recorded in regular surveys were reported (San Francisco Estuary Project 1997). These low catches were especially unusual because 1996 was a wet year. Other theories for the decline in striped bass include young fish entrainment at water export pumps in the Delta, greater migration of adult bass out to sea in El Nino storm years, and reduced “carrying capacity” of the system. Population estimates for legal-sized fish were about 1.8 million in the early 1970s and 0.8 million by the late 1990s. Striped bass populations increased to about 1.3 million in 1998 (Stevens and Kohlhorst 2001). The increased abundance in the late 1990s is unexplained, but may be due to factors allowing greater survival of young fish.

<u>American Shad (*Alosa sapidissima*)</u>

American shad populations in San Francisco Bay rapidly increased following its introduction in 1871. American shad spend most of their adult lives in the ocean, except for a brief spawning run into fresh water. Most of the shad in the area around San Francisco Bay spawn in the Sacramento River or its tributaries. Spawning migrations begin in March and peak spawning occurs in late May or June. Most of the young migrate downstream rapidly after hatching. By December, most are gone, but a few remain as long as a year. Many adults die after spawning, but some return to the ocean and spawn again in later years. American shad spawn least successfully in dry years.

White Sturgeon (*Acipenser transmontanus*) and Green Sturgen (*Acipenser medirostris*)

Two species of sturgeon inhabit the San Francisco estuary-Delta system, the white sturgeon and the green sturgeon. The white sturgeon is much more abundant in San Francisco estuary than the green sturgeon, partly because green sturgeon spend a greater portion of their lives in the ocean. Recruitment of white sturgeon appears to be greatest in years of high outflow.

The San Francisco Bay estuary supports the southernmost reproducing population of green sturgeon which spawn in the Sacramento River (Moyle and Yoshiyama 1992). The largest spawning population of green sturgeon in California is in the Klamath River Basin. The green sturgeon has been designated as a California Species of Special Concern.

Northern Anchovy (*Ergraulis mordax*)

The northern anchovy is the most abundant fish in San Francisco Bay. Northern anchovy are seasonally present in San Francisco Bay. They tend to enter the Bay in April of most years and migrate out to the ocean in the fall. In San Pablo Bay, anchovy abundance peaks later and drops more rapidly than in Central Bay. Most of the population spawns in the ocean, but spawning within the Bay has also been reported. Larval anchovies begin to appear in the Bay early in the spawning season of February through June. Northern anchovy show large fluctuations in numbers in response to both marine and estuarine conditions, but there are no obvious trends in recent years.

Pacific Herring (*Clupea harengeus*)

Pacific herring enter San Francisco Bay in late fall and winter to spawn and then return to the ocean. Most of the spawning in San Francisco Bay occurs in intertidal and shallow habitats of the central Bay and northern south Bay. Smaller young tend to be widely distributed in shallower habitats in South, Central, and San Pablo Bays. As they grow, they move to deeper waters closer to the Golden Gate. Most young Pacific herring emigrate from the Bay between April and August. Since 1974, there has been a trend toward increasing biomass of spawning herring. The spawning biomass of Pacific herring was the third highest on record in 1996 and 1997 at 89,000 tons (San Francisco Estuary Project 1997). The previous year produced the second-highest biomass on record at 99,000 tons. However 1998 yielded the lowest year on record. The lowest biomass estimates have occurred during or just after El Nino events (Watters et al. 2001). San Francisco Bay's population has not yet recovered from the effects of the 1997-1998 El Nino. Spawning biomass was estimated at 27,400 tons in 2000.

Tidal Marshes

Figure 3.3-3 shows tidal marshes in the project area. Three tidal marsh areas, Southampton Bay, Benicia Marsh and Martinez Marsh, occur in Carquinez Strait west of the Benicia-Martinez Bridge. Suisun Bay east of the bridge is ringed with tidal marshes. The tidal marsh system of Suisun Bay historically was much more extensive, but most of the tidal marshland was diked.

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3.3-3 – Project Area Marshes

Tidal marshes in the project area are a mixture of northern coastal salt marsh and coastal brackish marsh. Northern coastal salt marsh is dominated by salt-tolerant herbaceous and perennial species. These plant assemblages typically are found along the margin of the bay where they are exposed to periodic tidal inundation by salt water. Species typical of the northern coastal salt marsh community include pickleweed (*Salicornia virginica*), alkali heath (*Frankenia salina*), jaumea (*Jaumea carnosa*), alkali bulrush (*Scirpus robustus*), and arrowgrass (*Triglochin maritime*).

Coastal brackish marsh communities are found at the interior edges of coastal bays and estuaries and are influenced by both saltwater and freshwater inputs. Salinity in these marshes may vary considerably during the year due to seasonal changes in freshwater runoff. In the project area brackish marsh habitat typically occurs along channels at the upper end of tidal marshes where freshwater runoff can be pronounced. Plant species typical of this community include California bulrush (*Scirpus californicus*), American bulrush (*Scirpus americanus*), and narrowleaf cattail (*Typha angustifolia).*

Point Reyes Bird Observatory surveyed the vegetation of several of the tidal marshes in the project area as part of their studies on tidal marsh birds (Nur et al. 1997). Table 3.3-8 shows the percent plant cover of various species in these marshes. Pickleweed was the dominant plant species in Southampton Bay Marsh in Carquinez Strait and in portions of Goodyear Slough along the northwestern edge of Suisun Bay. In Bulls Head Marsh (Peyton Slough), Point Edith and portions of Goodyear Slough, cattail was the dominant species, indicating a stronger freshwater influence. At Rush Ranch in the interior portions of Suisun Marsh, rushes (*Scirpus* spp.) are the dominant vegetation.

Plant communities adjacent to the Shore terminal Pier were surveyed briefly in 2002. Most of the bayward portions of the site supported northern coastal salt marsh. The dominant native species observed at the site included pickleweed, salt grass, and spearscale (*Atriplex triangularis*). Alkali heath and marsh gum plant (*Grindelia stricta* var. *angustifolia*) were also observed. Portions of the coastal salt marsh habitat were infested with perennial pepperweed (*Lepidium latifolium*), an invasive, non-native weed species. Higher ground areas scattered throughout the marsh support clumps of coyote brush (*Baccharis pilularis*). Planted coyote brush and toyon (*Heteromeles arbutifolia*) shrubs form a boundary between parts of the salt marsh and upland disturbed areas. Coastal brackish marsh occurs in deeper channels within the coastal salt marsh habitat at the site. The most common species observed in the coastal brackish marsh habitat were tule (*Scirpus acutus*), cattail (*Typha* sp.) and common reed (*Phragmites australis*). Suisun marsh aster (*Aster lentus)*, a California Native Plant Society 1B species, was observed in brackish marsh habitat on the site. The marsh in the vicinity of the Shore terminal also is considered to have high potential to support the federal endangered Suisun thistle, the federal endangered and state rare soft bird's beak, the state rare Mason's lilaeopsis, the Delta tule pea (California Native Plant Society 1B list), and Delta mugwort (California Native Plant Society List 2) because of appropriate habitat on the site and the known occurrence of these species throughout the general project area.

Table 3.3-8
Vegetative Characteristics (percent cover shown) of Selected Marshes Along Suisun Bay, 1996

Common Name	Scientific Name	South-Hampton Bay Marsh	Bulls Head Marsh	Point Edith Marsh	Goodyear Slough A	Goodyear Slough B	Rush Ranch
Brass Buttons	Cotula coronopifolia	-	-	4.5	1.25	-	0.12
Common Cat-Tail	*Typha latifolia*	-	33.5	36.75	-	20.37	-
Common Reed	*Phragmites australis*	-	-	1.12	3.87	1.87	-
Common Pickleweed	*Salicornia virginica*	54.45	7.37	6.87	79.37	13.37	0.56
Common Tule	*Scirpus acutus* var. *occidentalis*	-	11.37	-	-	-	-
Coyote Bush	*Baccharis pilularis*	-	3.5	3.37	-	3	-
Fennel	*Foeniculum vulgare*	-	-	0.5	-	0.25	-
Gum-Plant	*Grindelia nana* var. *angulstifolia (humilis)*	5.87	-	1.0	0.12	3.37	-
Rushes	*Juncus* spp.	4.45	4.62	0.62	1	4.37	37.32
Meadow Foxtail	*Alopecurus* sp.	-	-	-	2.12	0.25	-
Mustard	*Brassica* spp.	-	0.12	-	-	-	-
Ox Tongue	*Picris echioides*	-	-	-	-	1.37	-
Peppergrass	*Lepidium hydrophilium*	10.75	0.37	12.75	0.05	4.75	15.01
Poison Hemlock	*Conium maculatum*	-	-	-	-	0.25	-
Poison Oak	*Toxicodendron diversilobum*	-	0.25	-	-	-	-
Ragwort	*Senecio hydrophilius*	0.75	-	-	-	-	-
Saltgrass	*Distichlis spicata*	12.45	3.75	17.0	9.87	8.37	16.76
Bulrush	*Scirpus microcarpus*	3.05	13.5	6.25	-	7.25	13.05
Seaside Arrow-Grass	*Triglochin maritima*	1.62	0.12	-	-	0.5	0.59
Silverweed	*Potentilla anserina*	2.25	-	-	-	-	9.26
Suisun Thistle	*Circium fontinale* var. *hydrophilium*	-	-	-	-	-	0.11
White Sweetclover	*Melilotus alba*	-	-	0.12	-	-	-
Water Parsley	*Oenanthe sarmentosa*	-	2	-	-	-	0.94
Wild Buckwheat	*Rumex* sp.	2.3	-	-	1.45	1.87	0.1
Wild Radish	*Raphanus sativus*	-	-	-	-	28.75	-
Unknown Grass		1.75	-	-	-	-	-
Unknown Herb		0.65	0.25	1.5	-	-	-
Unknown Thistle		0.05	-	0.25	-	-	-

Source: Nur et al 1997

Avifauna

The open water, mudflats, sloughs, and marshes of the project area provide a rich habitat for birds associated with tidal waters. Two species of seabird breed in the project area: western gull and California least tern (Carter et al. 1992). Western gulls breed at various locations throughout Carquinez Strait and Suisun Bay. The state and federal endangered California least tern has a small colony at Pittsburg at the eastern edge of the project area. Double-crested cormorants, a California Species of Special Concern, breed outside the project area in San Francisco Bay but may forage in the waters of Carquinez Strait and Suisun Bay. The state and federal endangered California brown pelican does not nest in San Francisco Bay but is present seasonally especially during summer months and forages in project area waters (Corps, EPA, BCDC, RWQCB and SWRCB 1998).

Like all of the waters of San Francisco Bay, the project area provides important habitat for wintering waterfowl. Scaup and canvasbacks (*Aythya valisineria*) are the most abundant waterfowl species in Suisun Bay (Chambers Group 1994). Particularly high densities of canvasbacks have been recorded in the Grizzly Bay portion of Suisun Bay (San Francisco Estuary Project 1997).

Large numbers of wintering shorebirds forage and rest in intertidal mudflat habitat in the project area. However, less than 1 percent of the wintering shorebird population in San Francisco Bay occurs within the project areas (Chambers Group 1994). Intertidal mudflat is most extensive along the margins of Grizzly Bay. Suisun Shoal in the center of western Suisun Bay just northeast of the Shore terminal pier is an important location for shorebird feeding and loafing (USCG and OSPR 2000). Suisun Shoal is also used by waterfowl for feeding and resting. Common shorebirds in the project area include dunlin (*Calidris alpine*), long billed curlew, American avocet (*Recurvirostra americana*), western and least sandpiper (*Calidris mauri* and *C. minutilla*), killdeer (*Charadrius vociferous*), long-billed dowitcher (*Limnodromus scolopaceus*), and marbled godwit (*Limosa fedoa*) (Corps, EPA, BCDC, RWQCB and SWRCB 1998)

Wading birds, including great blue herons (*Ardea herodias*), great egrets (*Casmerodius albus*), snowy egrets (*Egretta thula*), and black-crowned night herons (*Nycticorax nycticorax*), are resident in the project area and forage along the margins of project area sloughs. Great blue herons are relatively common in low-salinity salt ponds. Their distribution is not completely known, but includes sites in most tidal marshes where trees or brush occur for nesting. Great egrets and snowy egrets are known to nest in a number of marshes in the project area particularly in the Suisun Marsh complex (Chambers Group 1994). The distribution of black-crowned night heron nesting sites is not well known, but they are believed to nest in a number of areas in the north bay.

Project area marshes support a number of sensitive marsh birds including black rail, California clapper rail, saltmarsh common yellowthroat and Suisun song sparrow. Recent surveys of black rails have produced an overall mean density estimate of 3.44 birds per hectare in the project area (Spautz and Nur 2002). These studies indicate that black rails prefer marshes that are close to water (bay or river), large, away from urban areas and saline to brackish with a high proportion of pickleweed, tules and cattails. Based on the survey results and the amount of appropriate habitat, it is projected that approximately 12,000 black rails occur in Suisun Bay and Carquinez Strait (Spautz and Nur 2002). Within the project area, black rails are especially abundant at Southampton Bay in Carquinez Strait (mean density of 11.87 birds per hectare) and Cutoff Slough/Rush Ranch in the interior of Suisun Marsh (mean density of 10.11 per hectare). Black rails occur in Peyton Slough in the immediate vicinity of the Shore terminal but their density there is relatively low (mean density of 2.74 rails per hectare).

Suitable habitat for California clapper rail occurs in project area marshes and there are a number of records of this species within the project area, especially in the Point Edith Marsh (CDFG 2002). California clapper rails have been observed recently at Pacheco Creek (URS 2002b).

Suisun song sparrows occur in marshes throughout the project area (Nur et al. 1997). The population of this endemic subspecies is estimated at 44,100. The density of Suisun song sparrows in Peyton Slough near the Shore terminal is approximately 8.71 sparrows per hectare (Nur et al. 1997). Saltmarsh common yellowthroats also occur in project area marshes including Peyton Slough (Nur et al. 1997).

Marine Mammals

No major pinniped haul out areas occur in the project area. Workers at Shore Terminals report observing substantial numbers of California sea lions in the vicinity of the Shore terminal pier.

3.3.3 Impacts Analysis and Mitigation Measures

Impact Significance Criteria

An impact to biological resources was considered significant if:

- Any part of the population of a threatened, endangered, or candidate species is directly affected or if its habitat is lost or disturbed. Any loss of designated or proposed critical habitat for a listed species would be a significant adverse impact.

- If a net loss occurs in the functional habitat value of a sensitive biological habitat, including salt, freshwater, or brackish marsh; major marine mammal haul out or breeding area; eelgrass, major seabird rookery; or Area of Special Biological Significance.

- If the movement or migration of fish or wildlife is substantially impeded. Substantial impedance would include preventing or severely restricting passage over an area of at least several hundred feet for a period of a week or more.

- If a substantial loss occurs in the population or habitat of any native fish, wildlife, or vegetation, or if there is an overall loss of biological diversity. Substantial is defined as any change that could be detected over natural variability.

3.3.3.1 Shore Marine Terminal Routine Operations and Potential for Accident Conditions

Impact BIO-1: Noise Disturbance on Fishes and Birds from Vessel Traffic Movements

Ship traffic associated with Shore terminal operations represents an incremental amount compared to the background noise of ship traffic in San Francisco Bay and along outer coast tanker routes, thus disturbance to fishes from routine operations at the terminal are less than significant impacts (Class III). Birds local to the Shore terminal, including Peyton Slough, have adapted to vessel traffic, and impacts are less than significant (Class III).

Fishes could be disturbed by the noise of vessels visiting the Shore marine terminal. Suzuki et al. (1980) have documented studies showing that ship noise can affect fish behavior. These investigators believed that the sounds produced by large or high-speed vessels could frighten fish schools or cause them to change their migration routes. Studies also have suggested that the noises produced by fishing vessels and by underwater construction causes avoidance behavior in fishes (Myrberg 1990). Other studies have shown only slight avoidance behavior by fishes in response to ship noise (Freon et al. 1990; Neproshin 1978). Scientific SCUBA divers on Naples Reef in Santa Barbara have noticed that fishes scatter briefly as oil boats pass over the reef (personal communication, Ebeling 1985). Because ship noise represents a temporary disturbance and the ship traffic associated with operations at the Shore marine terminal represents an incremental amount compared to the background noise of ship traffic in San Francisco Bay and along outer coast tanker routes, noise and disturbance to fishes from routine operations at the terminal are expected to have adverse but less than significant impacts (Class III).

Similarly, vessel noise and activity could disturb birds in the vicinity of the Shore marine terminal or along tanker routes. Western gulls and western grebes were observed during a berthing operation at the Shore marine terminal in November 2002 and displayed no unusual behavior in response to the ship. Vessel traffic is commonplace throughout San Francisco Bay and water-associated birds that use the bay appear to have adapted to it. Vessels associated with the Shore marine terminal represent a small fraction of the total vessel traffic in San Francisco Bay and along outer coast tanker routes. The impacts of disturbance by vessels visiting Shore Terminals on birds is considered to be adverse but less than significant (Class III).

The Shore terminal pier crosses a vegetated marsh. All activities associated with Shore Terminals operations are on the pier itself. Marine terminal activities involve no direct disturbance of marsh habitat. The noise of operations on the Shore terminal pier potentially could disturb birds in the marsh. Sensitive bird species that occur in Peyton Slough near the terminal includes the State threatened California black rail and the Suisun song sparrow, a California Species of Special Concern. Because sensitive bird species breed in Peyton Marsh in the vicinity of Shore Terminals, it is likely that they wildlife using the marsh is adapted to the noise and activity on the pier. Impacts of disturbance from Shore Terminals operations on birds and wildlife in the adjacent marsh are considered adverse but less than significant (Class III).

BIO-1: No mitigation is required.

Impact BIO-2: Sediment Disturbance to Benthic Habitat from Vessel Maneuvers

The area near the Shore Terminals berth where propeller wash and bow thrusters may disturb sediments is very small compared to the amount of benthic habitat in the project area, and impacts of tanker sediment turbulence on benthic communities are adverse but less than significant (Class III).

When large ships, such as oil tankers, enter shallow water, the turbulence created by their hull and propellers can disturb the sediment in their path. Organisms living in or on the sediment could be displaced by the turbulence. The benthic environment of the ship channels is an unstable one of shifting sand (Entrix 1987). The benthic community that lives in this environment has very low diversity and is comprised of organisms adapted to this unstable environment. SAIC noted in a 1996 survey that stations within navigation channels near the Point Molate fuel pier had low infaunal abundance (Corps and Contra Costa County 1997). They attributed the scarcity of infauna to the effects of propeller wash. Because the navigation channels used by the tankers visiting the Shore marine terminal are the same as those used by a great number of ships visiting various ports in the Bay, the sparse infauna that characterizes these channels would be the same without the impact of the tankers traveling to and from the Shore terminal. The area in the vicinity of the Shore Terminals berth where propeller wash and bow thrusters may disturb sediments is very small compared to the amount of benthic habitat in the project area. Impacts of tanker turbulence on benthic communities are expected to be adverse but less than significant (Class III). Shore Terminals tankers would contribute to cumulative effects.

BIO-2: No mitigation is required.

Impact BIO-3: Maintenance Dredging

Loss of juvenile Dungeness crabs and young Chinook salmon would be a significant, adverse impact because dredging at the time when juveniles are moving through the area could disrupt the migration patterns of these species (Class II). Because of the low volume of material dredged, less than significant impacts (Class III) occur to plankton, other benthos, other fishes, and birds.

In order to maintain adequate depth for tankers, the berth on the north side of the Shore terminal pier must be dredged about every three years. Approximately 6,000 cubic yards (cy) of material were excavated in 2004. In the past this material has been disposed of at the Corps' Dredged Material Management Office (DMMO) designated disposal site SF-9 (Carquinez Strait). For this analysis it is assumed that Shore Terminals would continue to dispose of dredged wharf material to this site and/or other DMMO-approved sites, including upland reuse areas.

Plankton

Dredging can affect plankton in the vicinity of the dredging and disposal operations from turbidity generated by resuspension of sediments and from the resuspension of any pollutants associated with those sediments. Turbidity can have a number of adverse effects on planktonic organisms. Turbidity can affect plankton populations by lowering the light available for phytoplankton photosynthesis and by clogging the filter-feeding mechanisms and respiratory organs of zooplankton. The sediment at the Shore marine terminal consists primarily of sand sized particles. Therefore dredging of sediments at Shore Terminals and disposal of the material at the Carquinez Strait disposal site would not be expected to generate extensive turbidity plumes.

Sediments at the Shore marine terminal have been shown to have relatively low toxicity (ABC 2000). Therefore, minimal impacts to planktonic organisms are expected from the limited duration that the sediments would be in the water column. Previous studies of dredging operations have determined that water column effects of dredging are rarely a pathway of concern (Corps, EPA, BCDC, SF-RWQCB, and SWRCB 1998). Because of the low toxicity, infrequent dredging, low volume of material, and minimal turbidity, the impacts of maintenance dredging at the marine terminal on plankton would be adverse but less than significant (Class III).

Benthic Organisms

Maintenance dredging at the Shore marine terminal would displace the organisms living within the dredged sediments. Benthic organisms in sediments adjacent to the dredge area may be buried by suspended sediments or may be subjected to sublethal effects of turbidity such as interference with feeding and breathing mechanisms. A study of the effects of dredging on benthic organisms at a dredging site near Mare Island in northeast San Pablo Bay showed that the density of benthic organisms was greatly reduced in the area that was dredged annually compared to an undredged area (DiSalvo 1977). Dredging at the Shore marine terminal may decrease the density and diversity of benthic organisms in the dredged areas compared to what the infaunal community would be if the area were not dredged. However, the dominant species are expected to be similar. Infaunal assemblages in the project area are dominated by opportunistic introduced species including the Asian clam and the amphipod *Ampelisca abdita* (Thompson et al. 2000). Therefore, following dredging, the benthic community likely would rapidly return to an assemblage typical of the pre-dredging conditions. However, disturbance by dredging would tend to favor opportunistic introduced species at the expense of native species. Because the amount of bottom affected by dredging at Shore Terminals is a small percentage of the soft bottom area of Carquinez Strait and Suisun Bay, the impacts of maintenance dredging on infaunal organisms would be adverse but less than significant (Class III).

Epifaunal benthic species of concern in the vicinity of the Shore marine terminal include grass shrimp and Dungeness crabs. Maintenance dredging would disturb individuals of these species within the dredging area. Some individuals may be collected by the dredge. Others would leave the area. Because dredging occurs in a limited area and only every three years, the impacts on grass shrimp would be adverse but less than significant (Class III). However, juvenile Dungeness crab can be common in the project area especially in dry years, and could easily be entrained by the dredge (Corps, EPA, BCDC, SF-RWQCB, and SWRCB 1998). Loss of juvenile Dungeness crabs would be a significant, adverse impact because dredging at the time when juveniles are moving through the area could disrupt the migration patterns of the species (Class II). The impact could be mitigated to less than significant by avoiding dredging during September when first year Dungeness crabs are most abundant in Suisun Bay (Baxter et al. 1999).

Benthic organisms in the disposal area would be buried by the dredge spoils. Organisms in adjacent areas would be subjected to turbidity. At the Alcatraz site, impacts to benthic communities have been identified not only within the disposal area, where large mounds have formed, but also at a distance of 2,000 feet from the site (Segar 1988; Corps, EPA, BCDC, SF-RWQCB, and SWRCB 1998). Localized impacts to benthic organisms have been identified at other dredged material disposal sites off the coast of California (Chambers Group 2001). Because the Carquinez Strait disposal site is characterized by opportunistic benthic species, the disturbance of dredged material disposal would probably have less of an effect at this site than at sites in less disturbed locations (Corps, EPA, BCDC, RWQCB, and SWRCB 1998). Furthermore, the average of 6,000 cubic yards that may be discharged every three years at this site from Shore Terminals' maintenance dredging represents less than .05 percent of the amount of dredged material that may be discharged at this site when considered on an annual basis. Impacts of disposal of dredged material on benthic organisms would be adverse but less than significant (Class III).

Fishes

Fishes can be harmed or disturbed by turbidity from maintenance dredging at the Shore terminal and discharge of dredged material at the Carquinez Strait disposal site. Fishes rarely become entrained by the dredge itself but may be exposed to high levels of suspended sediments (Herbold et al. 1992). Fishes exposed to suspended sediments in the laboratory have been shown to suffer mortality as well as sublethal signs of stress (Soule and Oguri 1976; O'Conner et al. 1977; Neuman et al. 1982). Most fishes, however, will simply avoid the dredge and disposal areas during these operations. Dredged material disposal at the Alcatraz disposal site in Central Bay does not appear to cause mortality in fishes but has been observed to affect the movement of fish schools (Monroe and Kelly 1992). In a study of fish behavior at the Alcatraz disposal site, northern anchovy, white croaker, and shiner perch were observed to move away from the site immediately following a disposal event but returned within 1 to 2 hours. Because dredging at the Shore marine terminal would only occur once every three years and because the amount of material dredged would be extremely small, the impacts of maintenance dredging at the terminal and disposal of dredged sediments on most species of fish are expected to be adverse but less than significant (Class III).

Chinook salmon may be disturbed during maintenance dredging, primarily due to turbidity, although there is some potential that juvenile salmon could be entrained by the dredge. Turbidity during dredging is expected to occur only in the immediate vicinity of the dredging activity. However, because young Chinook salmon are known to occur in the vicinity of the terminal and because the winter and spring runs are so reduced, the impacts of maintenance dredging would be potentially significant (Class II). Impacts could be reduced to less than significant by conducting dredging in July and August, when winter and spring run smolt activity is lowest.

Birds

Turbidity plumes during maintenance dredging and dredged material disposal can affect piscivorous birds by making it difficult for them to see prey. Sensitive bird species that may forage on fishes in the project area include the state and federal endangered California least tern, the state and federal endangered brown pelican, and the double-crested cormorant, a California Species of Special Concern. Because maintenance dredging at Shore terminal is so infrequent, because the volume is so small, and because the sand-sized particles are expected to generate minimal turbidity plumes, impacts of maintenance dredging on birds would be adverse but less than significant (Class III).

Mitigation Measures for BIO-3:

BIO-3a: In order to reduce the entrainment of juvenile Dungeness crab, Shore Terminals shall schedule dredging to avoid the month of September when juvenile Dungeness crabs are most abundant in the project area.

BIO-3b: Although chances of entrainment of salmon is relatively low, to protect the salmon, Shore Terminals shall schedule dredging in July and August when winter and spring run Chinook salmon smolt activity is lowest.

Rationale for Mitigation: Avoidance of the times of the year when Dungeness crab and Chinook salmon smolt are present would reduce impacts to less than significant.

Impact BIO-4: Introduction of Non-Indigenous Species

Invasive organisms/introduction of non-indigenous species in segregated ballast water released in the Bay could have significant (Class I) impacts to plankton, benthos, fishes, and birds.

Tankers servicing the Shore marine terminal do not discharge unsegregated ballast water to the Bay. However, they may discharge segregated ballast water. Segregated ballast water is expected to be relatively free of chemical pollutants (see Section 3.2.3.1), but the ballast water may harbor exotic species that upon release may cause problems in the estuary's ecosystem. Exotic organisms have had a devastating effect on the estuary's planktonic ecosystem (Carlton 1979; Cohen 1998). For example, the Asian clam *Potamocorbula amurensis*, thought to have been introduced in ballast water, has depleted phytoplankton populations in Suisun Bay by its intensive feeding (San Francisco Estuary Project 1997). In addition to reducing the food base by feeding on phytoplankton, voracious feeding by the Asian clam also has directly reduced some zooplankton populations (Lehman 1998). Furthermore, introduced zooplankton species such as *Sinocalanus doerri* and *Pseudodiaptomus forbesi* appear to have outcompeted native species in Suisun Bay and the western Delta (Herbold et al. 1991). If a foreign species were introduced that could flourish in the Bay, impacts to the existing planktonic communities could be significant (Class I).

Introduction of exotic species, including the Asian clam introduced in 1986, has had a devastating effect on the benthic community of the estuary. Almost all of the dominant benthic invertebrate species in San Francisco estuary are introduced and extremely high densities of the Asian clam have been documented in Suisun Bay. As discussed in Section 3.3.2, the rate of invasions is increasing. The recently introduced green crab, for example, could affect benthic communities by preying on bivalves and outcompeting Dungeness crabs. Invasive organisms in ballast water could have a significant impact to the benthic community (Class I).

In addition to the introduction of invasive non-native species in ballast water, exotic fouling organisms can be introduced to San Francisco Bay by fouling on ship's hulls. Many species are thought to have been introduced to San Francisco Bay via ships' hulls (Carlton 2001). The phasing out of tributyltin (TBT) based paints to control ship fouling may increase the introduction of fouling species transported on vessel hulls. Introduction of non-indigenous species via hull fouling on ships servicing the Shore marine terminal also could have a significant adverse impact (Class I).

The introduction of exotic species to San Francisco Bay via ship traffic has not only devastated the San Francisco Bay ecosystem, it has resulted in the spread of exotic species to other areas of the west coast (Wasson et al. 2001). For example, San Francisco Bay is suspected of being an important source of introduction of exotic species to Elkhorn Slough (Wasson et al. 2001). The Australian reef-forming tubeworm (*Ficopomatus enigmaticus*), the European green crab, and the western Pacific tortellini snail (*Philine auriformis*) all invaded San Francisco Bay, probably via international ship traffic, before spreading along the California coast.

The introduction of non-indigenous species in ballast water discharges or by hull fouling could have a number of adverse effects on fish populations in San Francisco Bay. The eggs, larvae, or adults of non-native fishes may be present in ballast water discharges. Non-native species compete with native fishes. In addition, non-indigenous aquatic species such as the Asian clam tend to destabilize food webs. Asian clams feed voraciously at multiple levels in the food chain, ultimately reducing the food available for fishes (Cohen and Carlton 1995). Furthermore, because of the ability of Asian clams to filter large volumes of water, this species tends to concentrate pollutants such as selenium and organotins in its tissues (Periera et al. 1999). Fishes that feed on the Asian clam have the potential to ingest large quantities of toxins. Finally, ballast water may introduce harmful algae. Harmful algal blooms have caused fish kills in a number of places (Committee on Environment and Natural Resources 2000). Introduction of non-indigenous species has the potential to have a significant adverse impact on fishes (Class I).

The introduction of non-indigenous species by ballast water discharges or hull fouling could have adverse effects on bird populations in San Francisco Bay. Some waterfowl, especially diving ducks, consume large numbers of Asian clams. Because they filter large amounts of water, Asian clams may have high concentrations of contaminants in their tissues (Pereira et al. 1999). Birds that feed on this species thus may ingest large quantities of such harmful substances as selenium. In addition, toxic algae may be introduced in ballast water discharges. For example, more than 100 cormorants and California brown pelicans died in Monterey Bay in 1991 from domoic acid poisoning produced by the diatom *Pseudo-nitzchia* (Committee on Environment and Natural Resources 2000). The introduction of non-indigenous species from operations at the Shore marine terminal has the potential to have a significant adverse impact on water-associated birds in San Francisco Bay (Class I).

Mitigation Measures for BIO-4:

BIO-4: Mitigation Measure WQ-2 for vessel compliance with the California Marine Invasive Species Control Act and related CSLC requirements shall apply.

Rationale for Mitigation: As per WQ-2, Shore has no facilities to treat segregated ballast water and it may not be economically feasible to construct a system for treating ballast water to remove exotic species. Furthermore, effective systems for the treatment of ballast water to remove all associated organisms have not yet been developed.

Residual Impacts: Until a feasible system to kill all organisms in ballast water is developed, the discharge of ballast water to San Francisco Bay will remain a significant adverse (Class I) impact.

Impact BIO-5: Contaminants Associated with Routine Operations at the Shore Marine Terminal

Contaminant inputs into the water from Shore terminal operations are low when compared to other pollutant sources in the Bay. The impacts on plankton, benthos, fishes, and birds are considered adverse, but less than significant (Class III) impacts.

As discussed in Section 3.2.3.1, routine inputs of contaminants from the Shore marine terminal are low compared to other sources of pollutants in San Francisco Bay. Because the volume of these inputs is extremely low relative to receiving water, and because water movement in the vicinity of the marine terminal is good, rapid mixing is expected to occur. Thus, the input of contaminant from routine operations at the Shore terminal would not expose planktonic organisms to a high enough concentration of a toxicant for a long enough period of time to have any measurable effect on a plankton population. Therefore, the impact of routine inputs of pollutants from the Shore marine terminal on plankton populations is expected to be adverse but less than significant (Class III).

Chronic inputs of toxins from the Shore marine terminal could contribute to the pollutant body burden of benthic organisms in the vicinity of the terminal. Of all the aquatic communities, the benthic community at the terminal would be most susceptible to impacts from the chronic input of pollutants associated with routine operations, because many benthic organisms have low mobility and live in the sediments where pollutants accumulate. As discussed in Section 3.2.3.1, the chronic release of contaminants associated with routine operations at the terminal is low. Analysis of sediments at the Shore marine terminal has found that several metals (arsenic, chromium, copper, nickel, zinc) occur at concentrations high enough to have some effects on sensitive benthic organisms (NOAA ER-L level). Although the Shore Terminals' contaminant inputs may be affecting the benthic invertebrate communities in the immediate vicinity of the Shore terminal pier, the area of impact would be localized to the immediate vicinity of the terminal. The impacts to benthic organisms of chronic contaminant releases associated with routine operations at the terminal would be adverse but less than significant (Class III).

Input of pollutants from routine operations at the Shore marine terminal could add to the pollutant body burden of fishes in the San Francisco Bay estuary. For example, Whipple et al. (1987) have found that striped bass in the San Francisco Bay-Delta system contained relatively high levels of pollutants, especially metals and petrochemicals. Some of these pollutants showed strong correlation with poor health and condition, parasite burdens, and impaired reproduction. Studies of contaminant levels in fishes in San Francisco Bay showed that fishes collected in 1994 and 1997 had elevated levels of contaminants, including mercury, PCBs, dieldren, DDT, and chlordane (Davis et al. 1999). None of these chemicals would be expected to be associated with Shore marine terminal operations. Furthermore, as discussed in Section 3.2.3.1 inputs associated with routine operations at the terminal are low and represent a small percentage of pollutant inputs in San Francisco Bay. Therefore, chronic contamination to fishes from routine operations at the terminal are considered adverse but less than significant impacts (Class III). Chemical inputs from operations at the marine terminal will, however, contribute to significant cumulative impacts of pollutant levels in San Francisco Bay.

Contaminants in the San Francisco Bay estuary both reduce the abundance of food for birds and directly affect the health of populations. Diving ducks that consume mussels and clams in these waters, especially scaup, scoters, and canvasback, are known to have elevated levels of selenium, silver, copper, mercury, zinc, and cadmium. Levels of selenium and mercury exceed that known to reduce or impair reproduction (Chambers Group 1994). Caspian and Forster's terns, black-crowned night-herons, and snowy egrets have been found to have organochlorines and mercury at levels associated with impaired reproduction and thinning of egg shells (Ohlendorf et al. 1988). Double-crested cormorant eggs collected from the Richmond-San Rafael Bridge and the San Mateo Bridge had a much higher concentration of PCBs than double-crested cormorant eggs collected from Humboldt Bay (San Francisco Estuary Project 1997).

These high PCB levels were associated with various indicators of potentially adverse physiological effects in the eggs. Nevertheless, populations of double-crested cormorants in San Francisco Bay have continued to increase in recent years.

Discharges and small chronic leaks and spills associated with the marine terminal would be below levels that would have direct impacts on birds. Effects such as soiling of feathers from minor petroleum leaks and spills would be adverse but less than significant (Class III). Of the contaminants that have been of the greatest concern for birds in San Francisco Bay (selenium, mercury, DDTs, and PCBs) none are associated with operations at the Shore marine terminal; suggesting that the terminal is not contributing significantly to the body burden of these contaminants in San Francisco Bay waterbirds. Pollutants related to routine operations at Shore Terminals are judged to have an adverse but less than significant effect on birds (Class III).

<u>BIO-5: No mitigation is required.</u>

Impact BIO-6: Oil Spills at Shore Marine Terminal

The impacts of a spill on the biota at or near the Shore terminal have the potential to spread through Carquinez Strait and into Suisun and San Pablo Bays. Vulnerable biota are plankton, benthos, eelgrass, fishes, marshes, birds, and mammals. Per Operational Safety/Risk of Accidents section, small spills at the terminal (less than 50 bbls) should be able to be contained (Class II impacts). However, spills larger than 50 bbls may not be able to be contained and Shore Terminals may not have adequate boom to protect all the sensitive areas at the most risk that could be oiled within 3 hours of a spill from the terminal. Impacts from large spills are considered to be significant adverse (Class I) impacts.

This analysis of the impacts to biological resources of an oil spill at the Shore marine terminal considers the sensitivity of each component of the biota to oil and the vulnerability of its populations in the project area to a spill. Sensitivity considers how sensitive the organisms are to oil while vulnerability considers how much of a population could be affected by a spill. This assessment of oil spill impacts relied on documented biological damages to resources from historic spill events as well as computer modeling to determine the vulnerability of the biological resources within the Bay. Impacts to biological resources from historic spills were based on the literature review in the EIR for Consideration of a New Lease for the Operation of a Crude Oil and Petroleum Product Marine Terminal at Unocal's San Francisco Refinery at Oleum (Chambers Group 1994). The range of documented impacts from historic spills on various biological resources is briefly summarized here. The Unocal EIR contains a more detailed discussion of the scientific literature on the observed effects of spills.

This analysis considers the likely impacts to biological resources should a spill occur. The probability of a spill is discussed in Section 3.1.3.1. The probability of a major spill at the terminal is extremely low.

Documented biological damage from an oil spill has ranged from little apparent damage in the Apex Galveston Bay spill (Greene 1991) to widespread and long-term damage, such as the 1969 West Falmouth spill (Sanders 1977). Some of the factors influencing the extent of damage caused by a spill are the dosage of oil, type of oil, local weather conditions, location of the spill, time of year, methods used for cleanup, and the affected area's previous exposure to oil. Other levels of concern are the possibility of food chain contamination by petroleum products and the impact of an oil spill on the structure of biological communities as a whole.

Oil spilled into marine waters gradually changes in chemical and physical makeup as it is dissipated by evaporation, dissolution and mixing, or dilution in the water column. Various fractions respond differently to these processes, and the weathered residue behaves differently from the material originally spilled. Toxicity usually tends to decrease as oil weathers.

Laboratory tests have demonstrated the toxicity of petroleum hydrocarbons for many organisms. Soluble aromatic compounds in crude oil are generally toxic to marine organisms at concentrations of 0.1 to 100 ppm. Planktonic larval stages are usually the most sensitive. Very low levels of petroleum, below 0.01 mg/L, can affect such delicate organisms as fish larvae (NRC 1985).

Biological impacts of oil spills include lethal and sublethal effects and indirect effects resulting from either habitat alteration and/or destruction or contamination of a population's food supply. Directly lethal effects may be chemical (such as poisoning by contact or ingestion) or physical (such as coating or smothering with oil). A second level of interaction is sublethal effects. Sublethal effects are those which do not kill an individual but which render it less able to compete with individuals of the same and other species.

To evaluate the effects of a spill at the terminal, three sets of oil spill analysis from models were used. The results of all these models including figures are presented in detail in Appendix B. The first set of oil spill trajectory analyses is Oil Spill Scenarios No. 5 and No. 6 from the Unocal EIR (see Appendix B-1 of this EIR; Figures for Scenarios No. 5 and No. 6 are on pages 6 and 7 of Appendix B-1). Both of these scenarios modeled a 1,000 barrel spill in the tanker lane at the east end of Carquinez Strait about 1 mile east of the Shore Terminals pier. Scenario No. 5 modeled a spill in February during a flood tide. This spill showed that all oil beached within 27 hours. Within the first 3 hours, winds and currents carried oil out of the Strait and into Suisun Bay. Over the next 24 hours, oil spread extensively to contact intertidal mudflats in Grizzly Bay, and around Roe, Ryer and Simmons Islands. Shoreline contact occurred predominantly along eastern Grizzly Bay and the south side of Simmons and Dutton Islands. Scenario No. 6 modeled a spill that occurred during July winds and a flood tide. In this Scenario all oil beached after 12 hours. Most oil from this scenario spill beached within a few hours of release along the south shore of Suisun Bay from about Pacheco Creek to Middle Point.

The second set of oil spill analysis is from Shore Terminals Oil Spill Response Plan (Bluewater Consultants 2001). These analyses modeled a 5,380 barrel spill from the terminal under both summer and winter conditions. Under summer conditions, within

3 days the oil spread as far east as Chipps Island and as far west as the eastern end of San Pablo Bay. Under winter conditions during the 3 days the oil spread from Chipps Island on the east to the southeastern portion of San Pablo Bay on the west.

The third set of models was trajectory analyses performed for Clean Bay (in Wickland Oil Martinez 1998). These models tracked 4,000 and 10,000 barrel spills from the south side of Carquinez Strait near the Benicia Martinez Bridge. During the three days modeled, the 4,000 barrel spill spread to approximately Pinole Point in San Pablo Bay on the west to the southern boundary of Grizzly Bay. The 10,000 barrel spill spread approximately 0.5 miles further into San Pablo and Grizzly Bays.

Finally, the effects of a real spill, the 1988 Shell Martinez Spill, near the project area were used to evaluate potential oil spill impacts on biological resources. On April 23, 1988, about 9,500 barrels of San Joaquin Valley crude oil were accidentally released from an above ground storage tank at the Shell Oil Company Martinez Manufacturing Complex (Fischel and Robilliard 1991). The oil flowed into Peyton Slough and entered Suisun Bay and Carquinez Strait. The oil spread through most of Carquinez Strait and along the south shore of Suisun Bay as far as Port Chicago. The spill also contacted both sides of Roe Island and the southern shores of Ryer Island and Simmons Island.

<u>Plankton</u>

Impacts to plankton from an oil spill could range from direct lethal effects caused by high concentrations of oil in the surface layers of the water column after a major spill to a variety of sublethal effects such as decreased phytoplankton photosynthesis and abnormal feeding and behavioral patterns in zooplankton. Studies of oil spills have generally failed to document major damage to plankton, although lethal effects or severe oiling of individual zooplankton organisms in the immediate vicinity of a spill has been reported in a number of studies. Because plankton distribution and abundance are so variable in time and space, evidence of damage might be very difficult to document, even if it did occur.

Because the San Francisco Bay is a semi-enclosed system, plankton are more vulnerable to oil than on the open coast and are likely to be exposed to the oil for a longer period of time. Furthermore, recruitment from adjoining unoiled areas might be less available. Plankton communities in San Pablo and Suisun Bays would be particularly vulnerable to an oil spill because these areas are most isolated from recruitment from open ocean plankton populations. Furthermore, the phytoplankton populations in Suisun Bay have been decimated from heavy grazing by the Asian clam. Zooplankton species such as the copepod *Eurytrema affinis* and the opossum shrimp, *Neomysis mercedis* also would be particularly susceptible to an oil spill because they have restricted distributions centered on Suisun Bay and because populations have declined substantially in recent years. The most sensitive area for plankton within the San Francisco Bay estuary is in the entrapment zone where phytoplankton populations and important zooplankton species, such as the opossum shrimp, tend to concentrate. During periods of low river flow, the entrapment zone is located in the eastern part of Suisun Bay and the western Delta. During periods of high flow, it is located throughout

Suisun Bay and into Carquinez Strait. Within San Pablo and Suisun Bays, phytoplankton and zooplankton populations are most abundant over the shallow areas. The impacts to plankton of a spill at the Shore marine terminal have the potential to be significant (Class I or II).

Unocal EIR modeled Scenarios No. 5 and No. 6 both indicated that a 1,000 barrel spill in the vicinity of Shore Terminals could have a substantial adverse impact to plankton because each of them affected more than 10 percent of the open water habitat in Suisun Bay. Scenario No. 5 contacted 48.93 of the open water habitat in Suisun Bay and Scenario No. 6 contacted 16.97 of the open water habitat in Suisun Bay. Similarly, the trajectory analyses in the Shore Terminal Oil Spill Response Plan indicated that in the winter most of Suisun Bay west of Simmons Island and the eastern end of Carquinez Strait would have greater than a 50 percent probability of contact with oil. Under summer conditions the model indicated that much of Suisun Bay east of the Shore terminal pier would have a greater than 50 percent chance of contact with oil. Based on these analyses, plankton communities are judged to be at high risk of significant adverse impacts from a large spill at Shore Terminals.

Benthos

The impacts of an oil spill on the benthos within San Francisco Bay has the potential to be pervasive and long-lasting because oil can become entrapped within the semi-enclosed system of the Bay and repeatedly redistributed into the sediments. For example the impacts to mudflat communities of the 1969 West Falmouth spill were still detectable years after the spill (Blumer and Sass 1972). The benthos of San Francisco Bay is dominated by introduced opportunistic species that would recover rapidly from a spill. An oil spill would be likely to selectively affect more sensitive species such as amphipods, increasing the domination of hardy exotic species. Impacts to soft substrate benthos within San Francisco Bay would be most severe in intertidal mudflats where oil would wash ashore and become incorporated in the sediments. An oil spill within San Francisco Bay has the potential to cause significant impacts to the benthos in intertidal mudflat and shallow slough channels (Class I or II). On the other hand, benthic organisms in the ship channels and deeper portions of the bay would be less vulnerable to oil spill impacts because oil tends to float and would not be expected to coat the subtidal substrate the way it could intertidal mudflats.

Impacts to the benthos were documented in the 1988 Shell Martinez Spill (Fischel and Robilliard 1991). Surveys after the spill determined that benthic organisms were absent in the most heavily oiled portions of Peyton Slough. The abundance and diversity of epibenthic invertebrates were lower in the oiled sloughs than in unoiled areas. Grass shrimp abundance was lowest in the heavily oiled Peyton and West Martinez mudflats. Clams from Peyton Slough had higher concentrations of petroleum aromatic hydrocarbons in their tissues than clams from other areas.

The most sensitive benthic invertebrate resource that would be at risk from an oil spill at Shore Terminals is Dungeness crab. The juvenile stages of Dungeness crab are found throughout San Francisco Bay, but especially in San Pablo Bay. The juvenile stages of this species might be particularly vulnerable to oil. An oil spill could have significant, adverse impacts on Dungeness crab because a spill at the time when juvenile Dungeness crab are moving through San Francisco Bay would interfere with migration patterns and because a large spill could substantially affect a year class and result in a population decline (Class I or II).

The relative risk to the benthos from an oil spill can be evaluated by the percentage of the resource contacted by Scenarios No. 5 and 6 in the Unocal EIR. In Scenario 5, a 1,000 barrel spill near Shore Terminals contacted 68.6 percent of the intertidal mudflat in Suisun Bay. On the other hand, in Scenario 6, only 9.1 percent of the intertidal mudflat in Suisun Bay was oiled. Therefore, depending on the conditions at the time of the spill, impacts from a large spill at Shore Terminals on the intertidal benthos might or might not be substantial. Intertidal mudflat is at moderate risk from a spill at Shore Terminals.

Both Scenario No. 5 and No. 6 contacted 100 percent of the juvenile Dungeness crab habitat in Suisun Bay. However, oil in these scenarios contacted only 2.4 percent of the total juvenile Dungeness crab habitat in San Francisco Bay. Therefore, juvenile crabs in the local area would be at high risk from a spill at Shore Terminals but the juvenile Dungeness crab population as a whole would be at relatively low risk.

The oil spill trajectory analysis in Shore Terminals Oil Spill Response Plan indicates that much of the intertidal mudflat habitat in Suisun Bay has a greater than 50 percent probability of contact with oil during a reasonable worst case spill. The significant mudflat habitat at Suisun Shoal would be contacted within the first 3 hours of a spill. Under these oil spill scenarios most of the Dungeness crab habitat in Suisun Bay also would be contacted by oil. In addition, under winter conditions, oil would spread into southeast San Pablo Bay where additional intertidal mudflats and juvenile Dungeness crab habitat would be contacted by oil.

Eelgrass

Another marine resource within San Francisco Bay that would be particularly vulnerable to oil spill impacts is eelgrass. Many studies on the biological impacts of oil spills have documented impacts to marine grasses. For example, eelgrass growth and reproduction appear to have been impaired by oil contamination from the Exxon Valdez spill (Holloway 1991). Neither Scenario No. 5 or Scenario No. 6 contacted any eelgrass habitat. Under the winter conditions the modeled worst case spill might contact some eelgrass habitat in San Pablo Bay although the probability of eelgrass habitat being oiled would be less than 10 percent (Blue Water Consultants 2001). Under the 10,000 barrel spill trajectory analysis performed for Clean Bay some eelgrass habitat in San Pablo Bay would be contacted by oil (Wickland Oil Martinez 1998). No eelgrass was oiled in the 1988 Shell Martinez spill. Therefore, eelgrass is at relatively low risk from a spill at Shore Terminals. Impacts of an oil spill on eelgrass would be significant (Class I or II).

Fishes

Although major fish kills from oil spills have rarely been reported, evidence exists that oil pollution could have negative effects on all the life history stages of fishes. Malins and Hodgins (1981), in a literature review on petroleum effects on marine fishes, concluded that ample evidence existed that fishes exposed to petroleum in sediments, water, or through the diet accumulate hydrocarbons in tissues and body fluids. Laboratory studies thus have shown that the accumulation of hydrocarbons in fishes leads to a number of deleterious biological changes that can affect health and survival. Many of these effects were induced at relatively high concentrations that would be unlikely to be encountered in the marine environment. Moreover, adult fishes may be able to avoid an oiled area. There is some evidence of avoidance of hydrocarbons by fishes in the field but observations are few and circumstantial (NRC 1985). An indirect effect of oil spills on fish populations is a decrease in the invertebrate food base. Impacts of oil spills to adult fishes have varied from windrows of dead fishes observed in the West Falmouth spill (Sanders 1977) to no apparent effect.

Larval stages are sensitive to much lower concentrations of oil than those shown to affect adults. Moreover, adult fishes would be able to avoid an oiled area, but planktonic eggs and larvae would not; therefore, the egg and larval stages would be the most susceptible to adverse impacts. For example, in the 1989 spill of fuel oil from the tanker World Prodigy in Naragansett Bay, the early life stages of several fish species were observed to suffer significant impacts within the slick (Spaulding 1989).

Particularly sensitive fish species within the San Francisco Bay estuary include those with a restricted distribution, such as the federal and state threatened Delta smelt, as well as the anadromous fishes that pass through the northern reach on their way to the Delta and Central Valley rivers to spawn. All these species are at particular risk not only because a large percentage of their populations might be contacted by a single oil spill, but also because their populations have been declining in recent years. The project area is designated Critical Habitat for Delta smelt, winter run and spring run Chinook salmon and Central Valley steelhead.

The adult stages of anadromous fishes would probably be far less vulnerable to a spill than the early life stages. Adults pass quickly through the Bay on their way upstream to spawn and would be exposed to oil only briefly. Because most spilled oil is on the surface and the fishes are in the water column in the deep waters of the estuary, they would be unlikely to come into direct contact with oil. The juvenile stages of striped bass, steelhead and Chinook salmon, however, tend to spend considerable time in the shallow waters of the North Bay before they pass out of the Golden Gate and into the open ocean. If oil became trapped in the shallow waters of the North Bay, young striped bass and young Chinook salmon might be particularly at risk. Potential impacts of a spill within the San Francisco Bay estuary on Delta smelt and anadromous fishes would be significant (Class I or II).

Fishes that spawn in the Bay also might be particularly vulnerable to an oil spill because the egg and larval stages are so sensitive to oil. Important fish species that spawn primarily in the Bay include Pacific herring, longfin smelt, yellowfin goby, plainfin midshipman, bay goby, and topsmelt. Impacts to Pacific herring, which lay thin eggs on the partially hard substrate within the estuary, would be particularly susceptible to oil and impacts of a spill in the Bay could be significant (Class I or II). Several studies documented lethal and sublethal effects of oil on the eggs and larvae of Pacific herring following the 1989 *Exxon Valdez* oil spill (Norcross et al. 1996, McGurk and Brown 1996, Hose et al. 1996). Similarly, impacts to longfin smelt, which spawn primarily in the fresh-water at the eastern end of the estuary, could be significant if oil got into this part of the estuary (Class I or II). Impacts to other species that spawn in the estuary would only be significant in the case of an extremely expansive slick because these species are widely distributed (Class III for most spills). Species that spawn in both the Bay and the ocean would be less vulnerable. This latter group included Pacific staghorn sculpin, jacksmelt, and northern anchovy (Class III impacts). The federal threatened Sacramento splittail is present in the project area, but because its population is mostly in freshwater, oil spill impacts to this sensitive species probably would be less than significant (Class III).

To determine the relative risk to fishes from an oil spill at Shore Terminals, the percentage of habitat of sensitive fish species contacted by Unocal EIR Scenarios No. 5 and 6, a 1,000 barrel spill near Shore Terminals, was analyzed. Based on that analysis the relative risk to Pacific herring, juvenile Chinook salmon, striped bass, American shad, white sturgeon, starry flounder and the fish assemblage of Suisun Marsh was relatively low. Neither of these spill scenarios contacted Pacific herring spawning areas or the sloughs of Suisun Marsh. Scenarios No. 5 and 6 each contacted less than 0.1 percent of the shallow water habitat used by outmigrating Chinook salmon smolt. Therefore, although a large oil spill would have a significant (Class I or II) adverse impact on spring and winter run Chinook salmon and Central Valley steelhead because it would contaminate designated Critical Habitat, the risk of substantially affecting the population of these sensitive species is relatively low. Both of these scenarios also affected less than 10 percent of the preferred habitat of striped bass and white sturgeon, indicating a low risk to these anadromous species. However, Scenario No. 5 contacted 13.7 percent of American shad habitat and 10.7 percent of starry flounder habitat (Scenario No. 6 contacted less than 2 percent of the habitat of these species). Therefore, American shad and starry flounder could be considered to be at moderate risk from a spill at Shore Terminals.

The federal and state listed threatened Delta smelt is the sensitive species most at risk from a spill at the Shore marine terminal. Scenario No. 5 contacted 55 percent of the shallow water habitat in Suisun Bay where a large portion of the Delta smelt population could come in contact with oil. In addition, as discussed above, Scenarios 5 and 6 indicate that the plankton assemblage, which includes the zooplankton prey of the Delta smelt, is at high risk from a spill at Shore Terminals.

The larger oil spills modeled in Shore Terminals' Oil Spill Response Plan and the 10,000 barrel spill trajectory analysis performed for Clean Bay are consistent with the relative risk to sensitive fish species derived from the Unocal spill scenarios except that

Pacific herring spawning habitat in San Pablo Bay would be at some risk of contact from these larger spills and a larger percentage of habitat used by young Chinook salmon might be oiled.

Localized effects on fishes were observed in the Shell Martinez spill. Fish abundance was reduced in the oiled sloughs, but no region-wide impacts on fishes were detected (Fischel and Robilliard 1991). Studies following the Martinez spill showed that individuals of the staghorn sculpin (*Leptocottus armatus*) in the vicinity of the spill had enhanced hydrocarbon metabolizing enzymes (Spies 1989). These results suggest that the spill may have had localized sublethal effects on resident fish populations.

<u>Tidal Marshes</u>

Vegetated marshes within the San Francisco estuary are one of the habitats which would be most sensitive to an oil spill. In most oil spills that have contacted saltmarshes, damage has been noted to marsh vegetation (NRC 1985). When a large spill drifts ashore, tidal areas often are subjected to heavy oiling. In the case of saltmarshes, oil may become incorporated into sediments where it may persist for years. Furthermore, San Francisco Bay tidal marshes provide habitat for many sensitive species. Clearly any saltmarsh in San Francisco Bay would be likely to suffer significant impacts if it was contacted by oil from a spill associated with the Shore marine terminal (Class I or II). The Area Contingency Plan (USCG and OSPR 2000) identifies tidal marshes in San Francisco Bay as areas with high priority for protection in the event of an oil spill.

In Unocal Scenario No. 5, oil contacted 68.3 percent of the tidal marsh habitat in Suisun Bay and 12 percent in the entire San Francisco Estuary. In Scenario No. 6, 20.1 percent of the tidal marsh in Suisun Bay and 3.5 percent of the marsh in San Francisco Estuary were oiled. Marshes oiled in both these scenarios included Martinez Marsh, Peyton Slough/Bulls Head Marsh, Point Edith, Hastings Slough, Seal Island and Shore Acres Marsh. In addition, in Scenario No. 5 oil contacted Roe Island, Simmons Island, Freeman Island, Snag Island, and portions of Goodyear Sough. Project area marshes clearly are at high risk from a large spill at Shore Terminals. Sensitive plant species in these marshes also are at high risk from a spill at the Shore marine terminal. These sensitive plant species include the federal endangered Suisun thistle, the federal endangered and state rare soft bird’s beak, the state rare Mason’s lilaeopsis, the Delta tule pea (California Native Plant Society 1B list), Delta mugwort (California Native Plant Society List 2) and Suisun marsh aster (California Native Plant Society 1B list).

In the winter season oil trajectory run in Shore Terminals Oil Spill Response Plan, Hastings Slough, Point Edith, Seal Island, Bulls Head Marsh, Martinez Marsh and Benicia Marsh were all contacted by oil within 3 hours. Goodyear Slough, Southampton Bay, Ryer Island, and Roe Island were contacted by oil within 6 hours. For the summer season spill, Hastings Slough, Point Edith, Seal Island and Bulls Head Marsh were contacted by oil within 3 hours and Goodyear Slough, Benicia Marsh, Ryer Island, Roe Island and Martinez Marsh were contacted by oil within 6 hours. Other project area marshes were contacted by oil in these modeled spills but it took 12 hours or more for oil to reach them, indicating lower risk.

Approximately 148 acres of marsh shoreline were oiled by the 1988 Shell Martinez spill, of which 32 acres were heavily oiled (almost completely covered with oil), 15 acres were moderately oiled, and about 98 acres were lightly oiled (small isolated patches of oil) (Fischel and Robilliard 1991). The area of slough banks oiled was approximately 4 acres. The marsh vegetation was most heavily oiled along the shoreline east of Peyton Slough and at Ryer Island. Much of the heavily oiled vegetation was removed as part of clean up activities. By fall of 1989 areas that had been heavily oiled were recovering from the spill.

Avifauna

Oil spills can affect birds directly through oil contamination and indirectly through degradation of important habitat. The direct effect of oiling on birds is predominantly contamination of feathers, removing insulative qualities and reducing buoyancy (Holmes and Cronshaw 1977; Moskoff 2000). Oiling of feathers leads to elevated metabolic rate and hypothermia (Hartung 1967). Oiled birds may also ingest oil through preening of feathers or feeding on contaminated prey. Effects of ingested oil can range from acute irritation and difficulties in water absorption to general pathologic changes in some organs (e.g., Crocker et al. 1974; Fry 1987; Nero and Associates 1983). Ingestion of oil can also result in changes in yolk structure, and reduction in number of eggs laid and egg hatchability (Hartung 1965; Grau et al. 1977). Oiled birds that are able to return to a nest can contaminate the exterior of eggs, reducing hatchability (e.g., Hartung 1965; Patten and Patten 1977).

Indirect effects result principally from contamination of habitat where feeding occurs. These effects may be significant in shallow waters of bays, mudflats, and estuaries where waterfowl, rails, wading birds, and shorebirds feed. For these birds, loss or reduction in food resources can affect survival during migration and success of nesting efforts.

Marine birds are known to be conspicuous casualties of oil spills (e.g., Hope-Jones et al. 1970; Ford et al. 1991a, b). For example, it has been estimated that between 100,000 and 435,000 birds died within 3 months of the Exxon Valdez spill (Moskoff 2000). Those species suffering greatest mortality from past spills along the outer coast have been alcids, cormorants, loons, grebes, and scoters (Smail et al. 1972; Dobbin et al. 1986; Page and Carter 1986). These groups are more vulnerable because they are found in large numbers on the water. Other birds typically spend less time on the water or will relocate from the area affected by a spill (e.g., gulls, terns and pelicans; Sowls et al. 1980). Initial surveys of damage to birds following the 1988 Shell Martinez Spill reported that 450 birds were oiled and 192 died from the oil contact (Chan 1992).

Seabirds have regional populations that are centered predominantly off the outer coast. Therefore, the significance of impacts from an oil spill within San Francisco Bay are unlikely to have a significant effect on the regional population of most seabird species. Impacts to seabirds from a spill at Shore Terminals would be adverse but less than significant (Class III). Western gulls have breeding colonies throughout the project area, but this species has relatively minimal direct interaction with water and is not very vulnerable to oil spills.

Sensitive seabird species that occur in San Francisco Bay include the federal and state endangered California least tern, the state and federal endangered California brown pelican and the double crested cormorant, a California Species of Special Concern. These species spend much of their time out of contact with the water so they have a relatively low vulnerability to direct oiling. The impacts of an oil spill would be primarily loss of foraging habitat. Loss of foraging habitat for the California least tern is of particular concern because least terns breed at Pittsburg at the eastern end of the project area. Loss of foraging habitat during the least tern breeding season would be a significant adverse impact (Class I or II). Double-crested cormorants also have a small colony on Wheeler Island in Suisun Bay east of the project area. All of the modeled oil spill scenarios resulted in a substantial amount of oil on the waters of Suisun Bay indicating that the foraging habitat of the small colonies of California least tern and double-crested cormorant would be contaminated from a spill of 1,000 barrels or more at Shore Terminals. Therefore, foraging habitat of the breeding colonies of these seabirds is it high risk from a spill at Shore Terminals. California brown pelicans do not breed in the project area and their major roosting sites are in the Central Bay. Therefore, important foraging habitat for the California brown pelican is at relatively low risk from a spill at Shore Terminals.

Large migrant or wintering populations of loons, grebes, and scoters are found in San Francisco Bay from about October through March. In the Bay, the migrant or wintering waterfowl also includes large populations of diving or dabbling ducks that spend most time on the water where they can be contacted by oil spills. The San Francisco Bay estuary is used by several hundred thousand waterfowl from late fall through spring as a critical feeding ground. Substantial mortality of wintering waterfowl or loss of essential habitat would likely result from oil spills and would constitute a significant impact (Class I or II).

All of the modeled oil spills resulted in 10 percent or more of the open water in Suisun Bay being contacted by oil. Therefore waterfowl are at relatively high risk of localized impacts from a spill at Shore Terminals. Unocal Scenario No. 5, a 1,000 barrel spill near Shore Terminals under winter conditions, resulted in oil contact with 5.3 percent of the waterfowl habitat in San Francisco Bay with an estimated mortality of 50 to 200 birds. Therefore although some birds would likely be lost, the number is relatively small. However, particularly high densities of canvasbacks are found in Grizzly Bay. Unocal Scenario No. 5 resulted in a substantial amount of oil entering Grizzly Bay. Of the oil spill trajectories modeled for Shore's Oil Spill Response Plan, the winter trajectory showed that oil had a 40 to 50 percent chance of entering Grizzly Bay and under the summer conditions the probability was greater than 50 percent. Based on these oil spill models, wintering canvasback are at substantial risk from a spill at Shore Terminals.

In San Francisco Bay, habitat of rails, terns, wading birds, and shorebirds could also be contacted by oil spills (e.g., the 1988 Shell Oil Refinery spill, Palawski and Takekawa 1988). Direct effects on these birds from oil spills are suspected but difficult to assess. Observations of oil-streaked shorebirds are common immediately following oil spills, but carcasses are rarely recovered (Larsen and Richardson 1990). It is likely that shorebirds and wading birds are able to avoid oiling to some extent by retreating from exposed habitat. Even if contacted, they may be able to avoid hypothermia from light oiling because they remain on land and may find some shelter in vegetation. Nevertheless, preening of oiled feathers would lead to ingestion of oil and resultant pathological effects. Another serious concern is secondary impacts from contamination of food resources on beaches and mudflats. Not only could oil ingestion take place during feeding, the presence of oil might substantially reduce the food available to sustain these populations. The San Francisco Bay estuary is used by up to 1 million shorebirds as a critical feeding area in the Pacific Flyway. Substantial mortality of wintering shorebirds or loss of essential habitat would likely result from oil spills and would constitute a significant impact (Class I or II).

Less than 1 percent of the wintering shorebird population in San Francisco Bay occurs in Suisun Bay (Chambers Group 1994). Therefore, the risk of significant population impacts to shorebirds from a spill at Shore Terminals is low. However, based on the modeled oil spill scenarios intertidal mudflat habitat within the project area is at moderate risk of contact with oil from a spill at Shore Terminals, suggesting that there may be localized impacts to shorebirds. Suisun Shoal, an important shorebird foraging and roosting location near the Shore terminal pier is at particular risk from a spill at Shore Terminals. The oil trajectory analysis done for the Shore Terminals Oil Spill Response Plan indicated that Suisun Shoal would be contacted by oil from a spill at Shore Terminals within 3 hours.

The state threatened California black rail occurs in marshes throughout the project area. Based on recent surveys, close to 45 percent of the black rail population in San Francisco Bay occurs in marshes in Carquinez Strait and Suisun Bay (Spautz and Nur 2002). As discussed above, trajectory analysis of large oil spills originating at or near Shore Terminals, indicate that project area marshes are at high risk from an oil spill at the terminal. Therefore black rails are at high risk from a spill associated with operation of the Shore marine terminal. The federal and state endangered California clapper rail also would be affected if a spill at Shore Terminals fouled marshes in the project area. However, although some individual clapper rails might suffer adverse effects, most of the California clapper rail population in San Francisco Bay is located outside the project area and the overall risk of a Shore Terminals spill to the California clapper rail population as a whole is low. Other sensitive birds, such as the Suisun song sparrow and saltmarsh common yellowthroat, associated with marshes in the project area are far less sensitive to oil spills because they have little direct contact with the water.

Oiled birds recovered alive sometimes can be successfully cleaned and rehabilitated. Based on a review of the literature, the Unocal EIR estimated the success of mitigation by rehabilitation of oiled birds at 17 percent of the oiled birds for spills in the San Francisco Bay Area and 9 percent on the outer coast (Chambers Group 1994).

<u>Marine Mammals</u>

Significant impacts could occur if oil contacted a harbor seal haul out area (Class I or II). Oil on land and in the nearshore waters where harbor seals forage would produce greatest damage during the spring pupping season. Although adult harbor seals can die in oil spills, this would be relatively rare and have a minor effect on the population. From data in Mansfield (1970), heavy oiling of a haulout site might kill up to 5 percent of adult animals present. A more serious threat is oiling of newborn pups whose dense fur (lanugo) protects them from cold. Death could result from hypothermia, ingestion of oil, or starvation if separated from the mother. An oil spill from the Shore marine terminal has an extremely low probability of contacting a harbor seal haul out site. Therefore harbor seals are at very low risk from a spill at the Shore marine terminal.

<u>Ability to Protect Sensitive Resources from a Spill at Shore Terminals</u>

Shore Terminals' Oil Spill Response Plan (Blue Water Consultants 2001) was evaluated in the context of the Area Contingency Plan (USCG and OSPR 2000) strategies to protect sensitive resources most at risk from a spill at Shore Terminals. Shore Terminals' oil spill response capability is discussed in greater detail in Section 3.1.3.1.

Shore Terminals' Oil Spill Response Plan recognizes sensitive resources at most risk from a spill at the terminal. These are listed in Table 2-11 of the Oil Spill Response Plan. Sensitive areas that could be impacted within three hours of a spill are the greatest concern for immediate protection. These resources include Suisun Shoal, Hastings Slough/Point Edith/Seal Island, Bulls Head Marsh/Pacheco Creek, Martinez Marsh and Benicia Marsh. To protect these areas according to the strategies in the Area Contingency Plan, a minimum of 10,000 feet of boom is required. Although, through its oil spill response contractor NRC, Shore Terminals has access to almost 65,000 feet of boom, it appears that only 5,100 feet of boom are available from locations where they can be deployed within 3 hours. Therefore, Shore Terminals may not have adequate boom available to protect all the sensitive areas that may be oiled within 3 hours of a spill at the terminal. Furthermore, the Area Contingency Plan recommends using sonic devices to scare birds away from Suisun Shoal if this area becomes oiled. The Shore Terminals' Oil Spill Response Plan does not identify a source of such sonic devices, although it does identify a contractor for rehabilitating oiled wildlife.

<u>Mitigation Measures for BIO-6</u>:

The following mitigation measures shall be implemented by Shore Terminals to mitigate oil spill impacts to the maximum extent feasible:

BIO-6a: Implement all the mitigation measures included in OS-3 through OS-6 in Operational Safety/Risk of Accidents to either lower the probability of an oil spill or increase response capability.

BIO-6b: Demonstrate to the satisfaction of the CSLC that Shore Terminals can successfully implement its Oil Spill Response Plan and can deploy within 3 hours all the boom necessary to simultaneously protect all the sensitive resources at risk of contact with oil within 3 hours from a spill at Shore Terminals.

BIO-6c: Identify a source of sonic hazing devices to scare birds away from Suisun Shoal and demonstrate to the CSLC that these devices can be deployed within 3 hours of a spill at Shore Terminals.

BIO-6d: When a spill occurs, develop procedures for clean up of any sensitive biological areas contacted by oil, in consultation with biologists from CDFG and USFWS, to avoid damage from clean up activities.

BIO-6e: If damage occurs, the last resort is restoration and compensation. Any loss of resources shall be documented as soon as possible after a large spill. The sampling methods and design should be determined beforehand, and the plan should include provisions for getting resources onsite as soon as possible so that post-spill studies can begin immediately.

Rationale for Mitigation: Containment of small spills and protection of sensitive resources may reduce biological impacts to less than significant (Class III) for small spills. For large spills, significant impacts are likely. Sensitive areas that could be impacted within three hours of a spill are the greatest concern for immediate protection including Suisun Shoal, Hastings Slough/Point Edith/Seal Island, Bulls Head Marsh/Pacheco Creek, Martinez Marsh and Benicia Marsh. Implementing measures OS-3 through OS-6 help increase response capability and reduce risk of accidents. The Area Contingency Plan strategies require a minimum of 10,000 feet of boom for protection. Although, through its oil spill response contractor NRC, Shore Terminals has access to almost 65,000 feet of boom, it appears that only 5,100 feet of boom are available from locations where they can be deployed within 3 hours. Shore Terminals, therefore, by providing adequate boom available to protect all the sensitive areas that may be oiled within 3 hours of a spill at the terminal, would be providing the maximum feasible mitigation to aid in oil containment. In addition, the Area Contingency Plan recommends using sonic devices to scare birds away from Suisun Shoal if this area becomes oiled. The Shore Terminals' Oil Spill Response Plan does not identify a source of such sonic devices, thus, by identifying a source (assuming one is available locally), sonic devices should then be able to be used to scare birds away during cleanup actions. Consultation for cleanup actions with CDFG and USFWS will avoid damage that can occur during cleanup operations. Immediate documentation of any damage from oil spills is critical to the determination of compensation and methods for data collection determined prior to a spill aids in the effectiveness of documentation.

Residual Impacts: For large spills, oil is likely to contact sensitive resources and impacts would remain significant (Class I) even with mitigation.

3.3.3.2 Oil Spills from Vessels in Transit in Bay or along Outer Coast

Impact BIO-7: Biological Resources Impacts from Accidental Spills

A significant impact to biological resources (Class I or II impact) could result from spills of crude oil or product from a vessel in transit along tanker routes either in San Francisco Bay or outer coast waters.

The impacts to biological resources of oil from a spill associated with vessels servicing the Shore marine terminal would be similar to the impacts described above for a spill at the terminal. A significant impact to biological resources (Class I or II impact) probably would result from an accidental spill of crude oil or oil product from a vessel spill along tanker routes either in San Francisco Bay or outer coast waters. A larger oil spill is more likely from a vessel accident than a spill at the marine terminal. Most tanker spills/accidents and larger spills that cannot be quickly contained either in the Bay or along the outer coast would result in significant, adverse (Class I) impacts.

To identify the likely impacts to biological resources from a spill from a tanker traveling to or from the Shore marine terminal, the oil spill scenarios developed in the Unocal EIR for tanker spills was used (Chambers Group 1994).

Table 3.3-8 summarizes the resources most likely to be affected by a spill from tankers visiting Shore Terminals. This table includes the relative sensitivity of the resource to oil, the vulnerability of the resource within San Francisco Bay, and the relative risk from a spill from a tanker servicing the terminal. Sensitivity is an estimation of the extent to which the resource is likely to be harmed if contacted by oil. Vulnerability is the extent to which a large portion of the resource is within the area that is likely to be contacted by a spill from tankers. Species that have a large portion of their populations outside of the Bay or in nontidal areas are less vulnerable to a spill than species such as the Delta smelt, with most of their population within the Bay. The risk is the probability that a substantial percentage of the resource would be contacted by an oil spill from tankers based oil spill scenarios developed for the Unocal EIR. Clearly, given the wrong set of conditions, even a resource determined to be at low risk could suffer significant impacts from an oil spill from a tanker. However, based on the analysis presented above, resources determined to be at low risk are unlikely to be contacted by a spill from tanker operations. Species determined to be at moderate risk either have less than a 15 percent probability of any contact by medium or heavy doses of oil or their distribution is such that, although some portions of the resource might be at high risk, most of the resource is located in areas with a low probability of contact from a tanker spill.

Based on sensitivity, vulnerability, and the extent to which a tanker spill could contact a substantial portion of the resource, resources most likely to suffer substantial impacts from a tanker spill include:

- Rocky intertidal habitat
- Juvenile Dungeness crabs
- Wintering waterfowl (if spill occurs in winter)
- Double-crested cormorant
- California clapper rails and black rails
- Marsh sandwort (if spill occurs near Golden Gate)
- California least tern
- California brown pelican

Mitigation Measures for BIO-7:

BIO-7: Shore Terminals shall implement mitigation measures OS-8a and OS-8b of the Operational Safety/Risk of Upset section addressing potential participation in VTS upgrade evaluations, and Shore response actions for spills at or near the terminal.

Rationale for Mitigation: Response capability for containment and cleanup of vessel spills while transiting the Bay or outer coast is not Shore's responsibility. However, Shore's participation in these measures, particularly for providing response capability for spills near the terminal can help to reduce impacts to biological resources by increasing response capability. Impacts to biological resources from spills near the terminal caused by transiting vessels may be able to be reduced to less than significant with containment by Shore Terminals with implementation of OS-8b.

Residual Impacts: Even with these measures, the residual impacts to biological resources may remain significant (Class I).

3.3.4 Alternatives

3.3.4.1 No Project Alternative

Impact BIO-8: Effects on Biological Resources with No New Shore Terminals Lease

The alternative would eliminate the biological resources impacts associated with wharf operations at the Shore terminal resulting in a beneficial (Class IV) impact. Biological resources impacts (Class I, II and III) would be transferred to other marine terminals and would be similar to the Proposed Project. Shore has no responsibility for these other terminals.

With this alternative, the impacts to biological resources in San Francisco Bay from operations of the Shore marine terminal would be eliminated. These impacts include disturbance of vessel traffic and maintenance dredging, the risk of introduction of exotic species in ballast water, the chronic input to Bay waters of small amounts of contaminants, and the risk of an oil spill at the terminal.

The transfer of tanker traffic from Shore Terminals to another marine terminal would eliminate impacts to biological resources from operations at the Shore marine terminal but would transfer some of the impacts to another site. Because the additional tanker traffic at another marine terminal would not be expected to increase needed maintenance dredging at the other terminal or small chronic input of contaminants from storm runoff, this alternative would have slightly fewer operational impacts to biological resources than continued terminal operations at Shore Terminals.

Biological impacts associated with vessels would be transferred to another marine terminal and would be similar to the Proposed Project. These impacts include disturbance to biological resources from boat traffic, sediment disturbance generated by boat propellers and bow thrusters, introduction of exotic organisms in ballast water discharges and by hull fouling, and introduction of toxins used as anti-fouling agents on tankers. The potential impacts of spills on biological resources would depend on the location of the other terminal. Biological resources in close proximity to the terminal would be at greatest risk from an oil spill at the terminal. The potential impacts of a spill from a tanker would be similar to the Proposed Project.

If the No Project Alternative involved removal of the Shore terminal pier, temporary impacts to biological resources would occur by the noise and activity associated with pier removal operations and by disturbance of sediments during pier removal. These impacts would be short lived and are considered adverse but less than significant (Class III).

BIO-8: No mitigation is required.

3.3.4.2 Increased Use of Existing Pipelines for Continued Operation of Upland Facility Alternative

Impact BIO-9: Continued Shore Upland Operations via Existing Pipelines

Increased use of existing pipelines would have no impacts from routine operations. A pipeline spill or substantial leak that would reach a creek, stream, lake, or other water body could result in a significant, adverse (Class I or II) impact to biological resources, depending on whether the spill could be easily contained.

Except in the case of an accident, no impacts to biological resources would occur from the increased use of existing pipelines. The impacts of an oil spill from a pipeline to biological resources would probably be less than from a spill at the Shore marine terminal. If the spill occurred on land, oil would be transported less rapidly than a spill in San Francisco Bay, and the spill would be more easily contained. Impacts to biological resources could still be significant, however (Class I or II). The worst-case spill from a pipeline would most likely be if oil were spilled into a river or creek. The oil could contaminate a substantial amount of habitat if it was not rapidly contained and oil potentially could be transported to San Francisco Bay.

Mitigation Measures for BIO-9:

BIO-9a: For pipelines used by Shore, a plan shall be developed to contain spilled oil and protect sensitive biological resources in the event of an oil spill.

Rationale for Mitigation: For any pipelines that Shore would use or share use of, a protection plan addressing emergency containment actions would result in an increase in response capability. Small spills that can be quickly contained may be mitigated to less than significant.

Residual Impacts: Even with the implementation of protection and containment procedures, significant biological impacts (Class I) could still occur in the event of a large spill.

BIO-9b: Implementation of OS-10b.

Rationale for Mitigation: OS-10b refers to mitigation measure GEO-14 adhering to proper engineering design, inspection, maintenance and retrofitting of pipelines.

Residual Impacts: Significant adverse impacts (Class I) could occur if significant amounts of oil affected biological resources.

3.3.4.3 Modification to Existing Pipelines for Continued Operation of Upland Facility Alternative

Impact BIO-10: Continued Shore Upland Operations via Modifications to Existing Pipelines

Because the PG&E fuel oil line that would be used for this alternative is currently inactive, implementation of this alternative would place risk of a leak or spill in a pipeline where no such risk exists currently. Once constructed, no impacts should occur from routine operations. Significant, adverse (Class I or II) impacts to a waterbody could occur, depending on whether the spill could be easily contained.

The impacts of modifying an existing pipeline to allow continued operation of the upland facility would be similar to those of using existing pipelines discussed above. In the event of a pipeline break and spill or substantial leak, there is the potential that significant impacts could occur to biological resources. This could result in a significant, adverse (Class I or II) impact depending on whether the spill could be contained easily. Because the PG&E fuel oil line that would be used for this alternative is currently inactive, implementation of this alternative would place risk of a leak or spill in a pipeline where no such risk exists currently. However, a spill or leak from a pipeline is less likely than from tanker operations. Pipeline leaks and spills also are usually more readily contained and cleaned up than spills from tankers. Therefore, this alternative would have lower risk of significant adverse impacts to biological resources than the Proposed Project.

There is some potential that activities to make this abandoned pipeline usable, could disturb sensitive biological resources in the vicinity of the pipeline (Class I or II). Impacts to sensitive resources could be mitigated by avoiding activities in areas that support sensitive resources to the extent possible.

Mitigation Measures for BIO-10:

BIO-10a: For pipelines used by Shore, a plan shall be developed to contain spilled oil and protect sensitive biological resources in the event of an oil spill. Biological surveys should be conducted in areas that might be disturbed during pipeline refurbishment. If sensitive resources are identified in these areas, activities should be changed to avoid sensitive resources if possible. If resources cannot be avoided, construction measures shall be implemented to minimize construction impacts.

Rationale for Mitigation: For any pipelines that Shore would use or share use of, a protection plan addressing emergency containment actions would result in an increase in response capability. Surveys would help to identify sensitive resources. Small spills that can be quickly contained may be mitigated to less than significant.

Residual Impacts: Even with the implementation of protection and containment procedures, significant biological impacts (Class I) could still occur in the event of a large spill.

BIO-10b: Implementation of OS-10b.

Rationale for Mitigation: OS-10b refers to mitigation measure GEO-14 adhering to proper engineering design, inspection, maintenance and retrofitting of pipelines.

Residual Impacts: Significant adverse impacts (Class I) could occur if significant amounts of oil affected biological resources.